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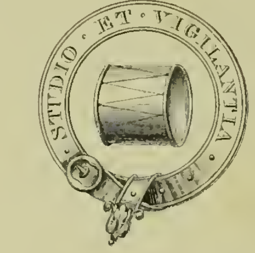

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Dr Alber Günther, F.R.S.
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with the kindest regards of
Henry Woodward

THE

PALÆONTOGRAPHICAL SOCIETY.

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A MONOGRAPH

OF THE

BRITISH FOSSIL CRUSTACEA,

BELONGING TO THE

ORDER MEROSTOMATA.

PART III.

[PTERYGOTUS AND SLIMONIA.]

PAGES 71—120; PLATES XVI—XX.

BY

HENRY WOODWARD, F.G.S., F.Z.S.,

OF THE BRITISH MUSEUM.

LONDON:
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A MONOGRAPH

OF THE

BRITISH FOSSIL CRUSTACEA

OF THE

ORDER MEROSTOMATA.

PART III.

Genus 1.—PTERYGOTUS, *Agassiz.*—*Continued.*

Species 3.—PTERYGOTUS RANICEPS :—H. Woodward. 1868. Pl. XVI, fig. 1.

PTERYGOTUS RANICEPS, *H. Woodward.* Quart. Journ. Geol. Soc., 1868, vol. xxiv, p. 294, pl. ix, fig. 3.

OUR knowledge of this species is confined to a single specimen obtained, like the preceding one, by Mr. Robert Slimon from the hard flaggy shales (Upper Silurian) of Logan Water, near Lesmahagow, Lanarkshire (see pages 46—52).

Head-shield obtusely triangular. Eyes prominent, marginal. Breadth of posterior border of carapace 6 lines; greatest length 4½ lines, from posterior border to eyes 3 lines; breadth of carapace at eyes 3½ lines; diameter of eye 1 line.[1] A small depression marks the centre of the carapace between the eyes, and a small elevation may be seen slightly posterior to them, also on the median line. Larval eye-spots not visible. Length of the six segments 7½ lines, greatest breadth 9 lines; no ornamentation is preserved upon any part of the integument.

The specimen here described and figured is preserved in the British Museum.

REMAINS OF PTERYGOTUS FROM THE WEST OF ENGLAND.

The following *seven* species[2] are given upon the authority of Mr. J. W. Salter, the late eminent Palæontologist to the Geological Survey, who had devoted many years to the investigation of this group; namely:

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[1] This tubercle probably marks the position of the ocelli.

[2] An eighth species, *Pterygotus punctatus*, Salter, has, since its publication, been determined to belong to the genus *Eurypterus* (see 'Quart. Journ. Geol. Soc.,' 1868, paper by H. Woodward, "On some New Species of Crustacea," &c., vol. xxiv, p. 290, plates ix and x).

Pterygotus Banksii, *Salter.* U. Ludlow Rock and Passage-Beds, Ludlow, Whitcliffe, &c.
— taurinus, *Salter.* U. Silurian, Ewyas-Harold, Herefordshire.
— ludensis, *Salter.* Old Red Sandstone, Ludlow, Trimpley, &c.
— gigas, *Salter.* Downton Sandstone and Passage Beds, Kington, Hereford.
— problematicus, *Salter.* U. Ludlow Rock, and Passage Beds, Whitcliffe, Ludlow Cornstones, Old Red Sandstone, &c.
— arcuatus, *Salter.* L. Ludlow Rock, Church Hill, Leintwardine.
— stylops, *Salter.* U. Silurian, Kington.

With the exception of *Pterygotus Banksii,* they are founded upon well-marked fragments only—which, however decisive as to their specific distinctness, need further confirmation by the discovery of more perfect remains.

Save in a few instances, therefore, it has not been thought desirable to redraw these detached portions, but rather to refer the reader to the large series of remains figured in the Geological Survey Monograph by Messrs. Huxley and Salter, and to reprint the descriptions of species as given by the latter,[1] merely correcting any obvious errors and making such few additions as we are enabled to do with confidence by our increased acquaintance with the more complete examples from other localities.

Should more perfect remains be discovered, as there is every encouragement to hope may be the case, we may yet, at some future day, figure as entire examples of these West of England *Pterygoti* as we have been enabled to do of those from beds of the same age in Scotland.

Species 4.—PTERYGOTUS BANKSII:—Salter. 1859. Pl. XVI, figs. 2—6.

Himantopterus Banksii, *Salter.* Quart. Journ. Geol. Soc., 1856, vol. xii, p. 32 and p. 99, pl. ii, fig. 5.
— — Siluria, 2nd ed., 1856, p. 266, foss. 66, fig. 1.
Pterygotus Banksii, *Salter.* Mem. Geol. Surv., Mon. I, 1859, p. 51, pl. xii, figs. 22—46.
— — Siluria, 3rd edit., 1859, p. 540.
— — Ibid., 4th edit., 1867, p. 239.

Named in honour of Richard Banks, Esq., of Kington, Hereford, who has made rich collections of the *Pterygoti* of that locality.

This small neat species, of which there are many specimens, both in the British Museum and in that of the Museum of Practical Geology, occurs with *Pterygotus gigas,* and spines both of Crustacea and fish, in the yellow tilestones[2] (Downton Sandstone) beds of Kington, Herefordshire. It is associated with the *Platyschisma helicites* and *Lingula cornea* (Sil. Syst.). These are the two species of shells which accompany the fossils of Lesmahagow above described; a good argument, therefore, even without other evidence, for regarding these Lesmahagow beds as the uppermost portions of the Ludlow rocks.[1]

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[1] If we omit *Eurypterus* (*Pterygotus*) *punctatus* (which occupies nearly two folio plates, and has twenty-eight figures devoted to its illustration), and *Pt. taurinus* (which was not published until 1868), the six remaining species occupy four folio plates and are illustrated by ninety-seven figures; all are in a very imperfect state of preservation, and consist only of detached plates and appendages.—H. W.

[2] Referring to this term the Rev. W. S. Symonds, M.A., F.G.S., Rector of Pendock, near Tewkesbury (who has paid especial attention to the geology of this district), writes as follows:—" The word ' tilestones'

The full size must have been from four to five inches long, but the specimens usually met with would probably not be above three or four inches. One or two show the connection of the body-rings with the head (Pl. XVI, fig. 5) and appendages, or with the tail joints (fig. 4). None are quite complete, and though we have nearly all the parts they are usually disjointed.

The carapace (Pl. XVI, figs. 2 and 3) is a broad semioval; its length is as six to seven, except when lengthened or shortened by pressure. It is regularly convex, a little produced in front, smooth, and bears the small oval eyes rather more than half way up the head. They are much smaller than in *Pterygotus bilobus*, being not above one fourth the length of the carapace, and very convex.

The body is at first wider than the head, and then tapers backwards (Pl. XVI, fig. 5). The first ring is very narrow; the second twice as broad, and with the usual dilated extremities; the third, fourth, and fifth somites strap-shaped, arched in the middle, and direct on the sides, so that the segment appears much bent. The ends are truncate, in the anterior rings widest behind, and in the posterior ones tapering backwards.

The hinder rings (Pl. XVI, fig. 4) become gradually less transverse, the eleventh only two and a half times wider than long, and the twelfth above once and three quarters its own length.

The caudal joint (telson) differs, in its expanded form, materially from that of *Pterygotus bilobus.* It is about three fourths as long as wide; narrow at the base, with two short ridges running down from either angle; then expanded with somewhat convex sides towards the wide subtruncate apex; the outer angles are rounded off, the terminal notch shallow, and a short median keel continued from it one third up the segment.

The sculpture of the head is not known. On the body-rings a transverse lineation, running into open plicæ on the sides, occupies the front margin for not quite half the segment; a few plicæ are intermixed with the lines.[2]

(now happily abandoned by Sir R. I. Murchison) is altogether inappropriate as applied to the Ledbury rocks. There is not a stone capable of being formed into a *tile,* from the Downton sandstone to the Cornstones of Wall Hills; but there are thin muddy marls over the Downton beds, which would have been tilestones had they sufficiently hardened, and which are doubtless the equivalents of the true tilestones. I consider, therefore the term 'passage-rocks,' as used by Sir R. Murchison in the last edition of 'Siluria' to be the more appropriate appellation for these transition beds, and one which allows to the palæontologist as well as the physical geologist, a broad margin for the line of demar ation between the two great epochs of the Silurian and the Old Red." ('Quart. Journ. Geol. Soc.,' Lond., 1860, vol. xvi, pp. 193—197.)

[1] 'Quart. Journ. Geol.,' vol. xii, 1856, p. 32. See also Part II of this Monograph, pp. 46—52.

[2] On a caudal joint (pl. xii, fig. 46, Mem. Geol. Surv., Mon. I) a lineation, parallel to the outer border,

The *Antennæ* (Geol. Surv. Mem., Mon. I, pl. xii, figs. 30 and 40) are remarkably slender and straight; the base is large and broad, suddenly attenuated into the shaft, which is only a tenth of an inch wide, and three quarters of an inch long, beset with close small teeth, and furnished with three larger conical ones nearly straight; the central one as long as the width of the shaft. In the fragment of an antenna figured by Mr. Salter (Mon. I, pl. xii, fig. 40) from the Ludlow Rocks, the intermediate teeth are a little longer in proportion.

Ectognaths.—The basal joints are flask-shaped, much more elongate in the neck than those of *P. bilobus*, and less swelled at the base. [It is possible, Mr. Salter adds, they may not belong to this species at all, but to *Eurypterus linearis*, a species which occurs in the same beds; we do not yet know this joint in *Eurypterus*.[1]] The base is subquadrate, quite rectangular on the outer upper margin; the notch for attachment of the other joints is immediately beneath this angle, and tapering into the long neck, which has a sharp ridge posteriorly, and, together with the terminal lobes, equals the length of the basal portion. The teeth are minute.

The *Swimming-foot* (Pl. XVI, fig. 5) has a characteristic shape; the upper joints (fourth and fifth) are rather narrow; and the penultimate (*p*), instead of being simply conical, as in *Pt. bilobus*, is ovate, with the outer border especially convex. It is notched above to receive the fifth joint, and below divided into very unequal lobes. The terminal palette (*d*) is true oval, rather blunt at its origin, and more pointed at the extremity. It is nearly equal to the penultimate joint in length, but considerably narrower.

The *Post-oral plate* (Pl. XVI, fig. 6) differs a little in shape, but not specifically, unless the greater amount of ornament in some specimens be considered sufficient to separate it. The shape is elongate oval, the greatest width is at the upper third, the base is subtruncate, the apex has a shallow obtuse notch. At the lower fourth there is evidently a tubercle of attachment, and such as occurs in a more linear shape in other species. [It is desirable to find out the post-oral plate of *Eurypterus*, which is probably very similar.]

The sculpture is very conspicuous over the upper half; it consists of nearly straight or very slightly curved plicæ arranged in arched lines, and ending abruptly against the outer margin. In the sandstone specimens the sculpture does not extend so far down, but it is identical in structure.

Localities.—Upper Ludlow Rock, Ludlow Lane, Whitcliffe (and Batchcot ?), Parlan, exterior slope of the Woolhope Valley (Mus. P. G.), Kington, Herefordshire (Mr. R. Banks' cabinet), Passage Beds, Ludlow Railway cuttings (cabinets of Messrs. Lightbody and Marston, Ludlow Museum, British Museum, and Museum of Practical Geology, Jermyn Street.)

is distinct, but it is uncertain if this specimen be of the same species; it has a strong median groove down the under side, and is less expanded in form than *P. Banksii.*

[1] Several of these minute detached basal joints are figured by Mr. Salter (see Mem. Geol. Surv., Mon. I, pl. xii, figs. 29 and 29*a*), but as they present no character of importance, and as their connection with *Pt. Banksii* seems doubtful, we have not thought it needful to reproduce them here.—H. W.

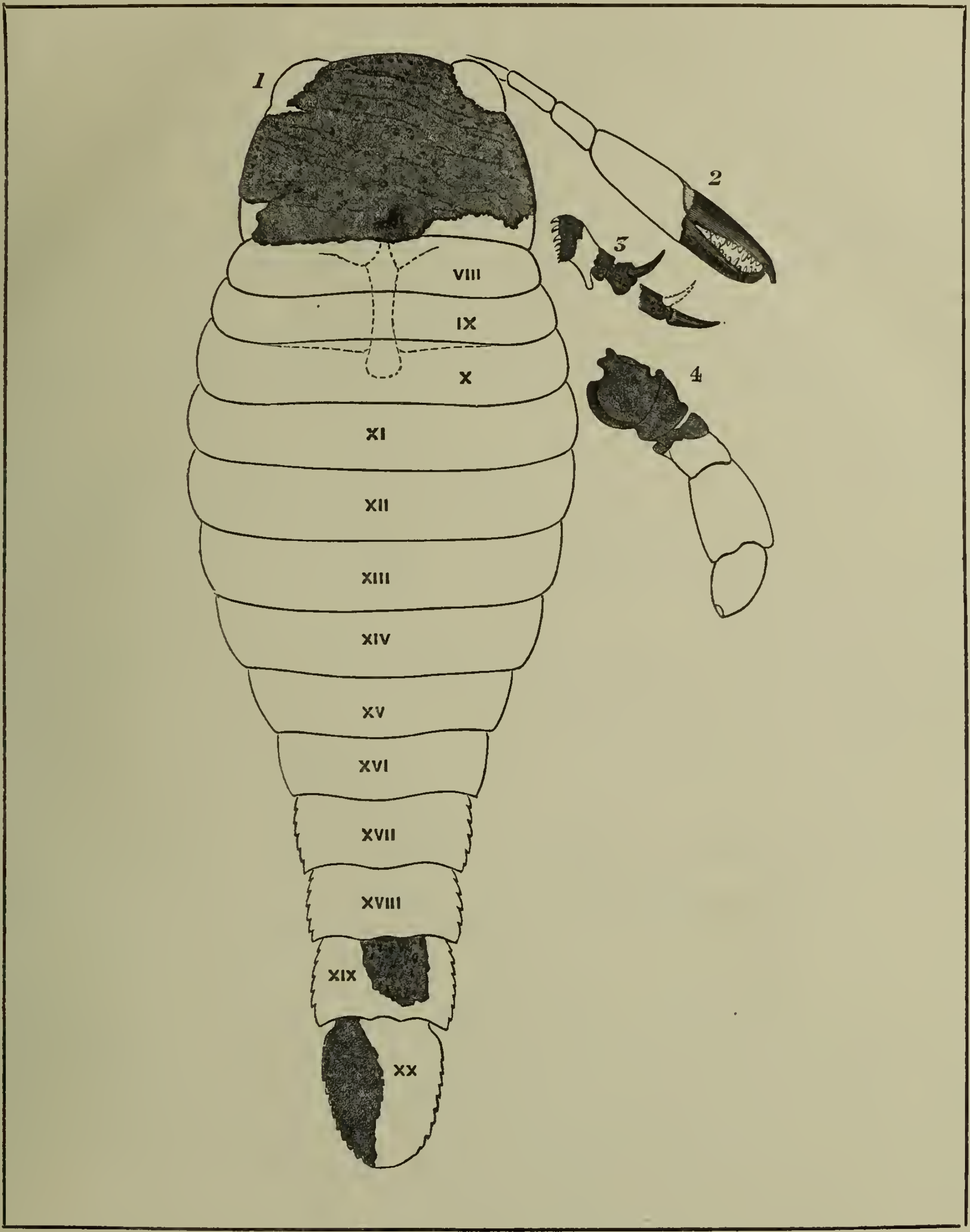

Fig. 14.—*Pterygotus taurinus*, Salter. Ledbury series, Ewyas Harold, Herefordshire. After a sketch by Mr. J. W. Salter, F.G.S. (For description see page 76.)

The shaded parts, namely, 1. the head-shield; 2, the chelate antenna; 3, the endognath; 4, the ectognath, or swimming-foot; and parts referred by Mr. Salter to the penultimate segment (xix); and the last segment or "telson" (xx); are alone preserved.—H. W.

Species 5.—PTERYGOTUS TAURINUS:—Salter. 1868. Woodcut, Fig. 14, p. 75.

PTERYGOTUS TAURINUS, *Salter.* Report Brit. Assoc., Norwich Meeting, 1868. Trans. of Sections, p. 78.

This new species was obtained from the lowest Old Red, or Ledbury Shales formation. It is a very large one, and must have measured 7 feet in length when perfect. Its head is very square; the base of the swimming-foot small in proportion to that of other species. The chelate antennæ have the apices very greatly hooked and the teeth close. Only fragments of the body-rings have been found. The tail-joint appears to have been oval. The specimens were found at Ewyas Harold, and are in the cabinet of Dr. McCullough, of Abergavenny.

The Woodcut, given on page 75, is reproduced from an original sketch by the late Mr. J. W. Salter, drawn at the time his note was written. The parts known only are shaded; the outline was intended by Mr. Salter to convey an idea of the general form.

Measurements given by Mr. Salter:—

1. Head a foot wide.
2. Portion of chelate antennæ preserved, 6 inches long.
3. Portions of two palpi, 4 inches.
4. Basal portion of swimming-foot, 5 inches.

Species 6.—PTERYGOTUS LUDENSIS:—Salter. 1859. Pl. XVI, figs. 7—9.

PTERYGOTUS LUDENSIS, *Salter.* Mem. Geol. Surv., Mon. I, 1859, p. 79, pl. xiv, figs. 1—13; pl. ix, fig. 18?; pl. xii, figs. 1—5 (and 6?).
— — *Salter.* Siluria, 4th edit., 1867, p. 140, and p. 238.

Under this name Mr. Salter describes, with but little doubt of its specific distinctness, the fragments of a fine species very abundant indeed in the transition beds of Ludlow, shown as they are in the railway cutting near that town. All the specimens are in the cabinets of Mr. Lightbody and his son. The same species is found at Trimpley, near Kidderminster, and we are indebted to the late Mr. G. E. Roberts for the means of illustrating some points not clear in the specimens at Ludlow.

The materials consist of several body-rings[1] of a large size (Pl. XVI, figs. 7 and 8); a fragment of the caudal joint;[2] a specimen showing nearly all the body-joints and telson in position, but a good deal obliterated; the serrate basis of the swimming-feet, mandibles with palpi, antennæ; and to these must be added the post-oral plate, the bilobed

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[1] Mem. Geol. Surv., Mon. I, pl. xiv, figs. 2, 3, 4, 11: these are all fragments merely.—H. W.

[2] Ibid., fig. 12; only a fragment.

" (abdominal? appendages,"[1] and possibly a portion of a swimming-foot, together with an imperfect caudal joint. (Mem. Geol. Surv., Mon. I, pl. xii, figs. 4—6.)

The two last may, however, belong to *P. gigas*, a species very nearly allied, and to which (says Mr. Salter) for some time I believed the whole of the specimens referable. Again, there is so much resemblance in certain points to the Scotch species, *P. anglicus*, that it requires nice discrimination to separate the three forms. The characters of the antennæ, and also of the caudal joint, will, I think, be sufficient. And if subsequent observation should tend to show that this "Tilestone" species is the opposite sex of the *P. gigas*, it will still have been worth while provisionally to separate them.

Body-joints.—The complete specimen (Pl. XVI, fig. 7) shows that the body was not greatly elongated, the segments being all rather widely transverse, the eighth, for instance, being fully four and a half times as wide as long; the ninth and tenth are gradually narrower, but the eleventh still shows a width two and a half times greater than the length, while in *P. anglicus* the corresponding joint appears to have been no more than one and a half times the length.

The penultimate joint is squareish, or rather inversely conical, not much expanded below. It is about one fourth wider than long, as in *P. anglicus*, and this at the hinder part only. A strong central keel runs down its whole length, covered with large squamæ, and the margins are similarly ornamented. (See Pl. XVI, fig. 8.) If the caudal joint (Mem. Geol. Sur., Mon. I, pl. ix, fig. 18) be of this species, it has lost the terminal apiculus. It is nearly elliptical, the base truncated. It is fully four inches long.

The sculpture of the body-rings consist of open semicircular squamæ, flattened along the anterior border and more convex behind, occupying the anterior half of the segment in the front rings, and more in the hinder ones, till, in the ninth and tenth, they nearly cover the segment. On the sides they are more elongated, and, as in other species (*P. gigas*, for instance), those on the upper side are more elongate and pointed than those on the lower. All the plicæ are prominent and sharp-edged. There are very few intermediate ones, but the surface of the cuticle is generally roughened between the plicæ. Some segments show the plicæ very large, and must have been at least fourteen inches broad. Other specimens in the Ludlow Museum show four or five rings overlapping, and some are subcylindrical, and with sharp edges. The caudal joint is broad-oval and shortly apiculated, less abruptly so than in *P. anglicus*, which, too, has a less regularly oval form, the greatest breadth being below the middle. It is marked all the way down dorsally by a strong carina covered with broad squamæ, and the edges are also squamate in two or three rows. In the specimen from Trimpley, the sides are marked by oblique radiating interrupted lines.

The *Thoracic plate* ("Epistoma and Labrum," Salter) is as large as that of *Pt. anglicus*, and nearly like it in all its parts.

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[1] These are still undeterminable; they may be cephalic, or thoracic appendages, they are clearly *not* abdominal; they probably do not belong to this genus at all: see figures 25—27, page 91.—H. W.

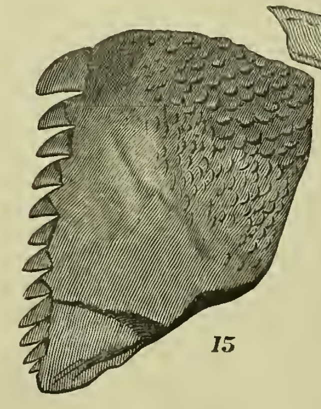
Antennæ.—These resemble in general form those of *P. anglicus,* but have a more slender shaft, tapering more quickly and narrower and with more conical teeth. The teeth are intermediate in form between the species above mentioned and *P. problematicus,* the central one being long-lanceolate, and the secondaries narrow, conical, and with coarse striæ. The base of the fixed claw is furnished with a set of stiff spines, as in *P. problematicus,* but the whole chela is proportionably much shorter.

Endognaths.—Of these there seem to be *three* pairs, as in *P. anglicus,* and of very similar shape. The joints of the palpus, like those of *P. gigas,* have a squamose ridge, along each side, and the ends of the joints are bilobed. The second joint is three and a quarter times as long as broad. This is nearly the proportion in *P. anglicus,* where it is three times the breadth. (See Woodcut, below, Fig. 16.)

The other pairs of jaws have their anterior margin more curved, and the teeth set on a more convex edge than in *P. anglicus.* The first tooth is set more backward, thick, and curved at the base, and all are more curved than in the Scotch species.

The *Post-oral plate* may belong either to this or to *P. gigas* (see Woodcut, Fig. 18, p. 84).

Base of Swimming-foot (Pl. XVI, fig. 9).—These portions are very characteristic in all the species. In this the shape most nearly resembles that of *P. gigas,* and the teeth are short and blunt, as in that species, but the neck is shorter. From *P. anglicus,* the shorter form, the short neck, blunt teeth, and convex upper lobe overhanging the teeth distinguish it; but the sculpture raised into thick, prominent, boss-like plicæ is almost identical. The lower edge is tuberculate, and even spinous; our figure does not show this part. A little comparison of this specimen with *P. anglicus* will show that both in the upper or front edge and on the lower or hinder edge the terminal lobe is more prominent in *P. ludensis.*



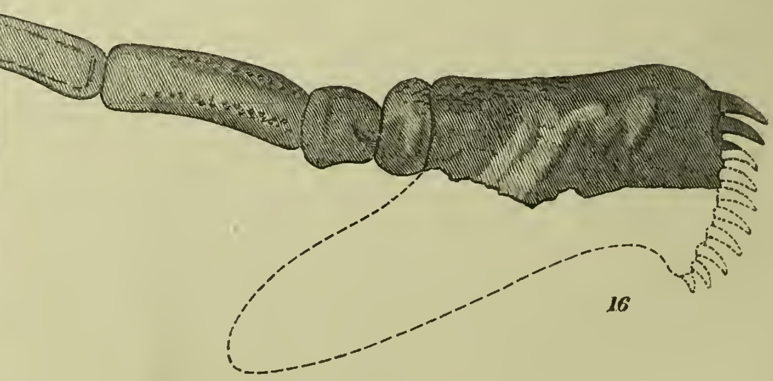


Fig. 15.—Mandibular border of ectognath of *Pterygotus ludensis,* Salter, from Mr. Lightbody's Cabinet.
,, 16.—An endognath of *Pt. ludensis,* with its palpus. Museum Pract. Geology. Both specimens from the Basement-beds of the Old Red Sandstone, Ludlow Railway, Ludlow.

Thoracic Appendages[1] (?) (Mem. Geol. Surv., Mon. I, pl. xii, figs. 4 and 5).—The nature of these is not understood, nor do these specimens show the characteristic irregular base. But they differ specifically both from the similar appendages referred to *P. problematicus* and *P. arcuatus*, by their deep terminal notch. The outer edges are thickened, and the substance of the whole appendage is thick. The lateral plicæ run down in oblique rows on the inner (?) surface becoming more and more linear, till they become straight lines, like the pennæ of a feather, and on the outer side; impressed distant converging striæ cut up, as it were, the whole surface into narrow bands, the termination of these bands being serrated projections in *P. problematicus*, but in this species they come to an even edge on the notched border.

Ovisacs (?).—The egg-packets (*Parka*), found in plenty with this species at Trimpley, show the membranous veil in several cases. The ova of considerable size, generally oval, and placed a little apart in the younger packets, but they become hexagonal or polygonal, from mutual pressure, in the older ones (see Pl. XVI, figs. 10 and 11).

Localities.—Base of the Old Red Sandstone, at Ludlow Railway Station (abundant); at Trimpley, north of Bewdley, associated with *Pteraspis Banksii.*

Species 7.—PTERYGOTUS GIGAS :—Salter. 1859.

PTERYGOTUS GIGAS, *Salter*. Mem. Geol. Surv., 1859, Mon. I, p. 83, pls. viii and ix.
— PROBLEMATICUS, *Banks*. Quart. Journ. Geol. Soc., vol. xii, 1856, p. 93, &c.

Although there are very strong grounds for considering the remains referred to this species to be only English representatives of the great Scotch *Pterygotus anglicus*, figured in Part I of this Monograph, we have not treated it here as synonymous because we have no new or more perfect materials to offer than those heretofore described in the 'Geological Survey Monograph.' Therefore, in deference to Mr. Salter's determination, we retain the species, giving his diagnosis, with only a few additional notes where needed.

For some years a large *Pterygotus* has been known in the beds of Downton Sandstone (Uppermost Ludlow Rock), worked for building purposes at Kington, Herefordshire, and a description of many of its parts was given by Mr. R. Banks, of Ridgbourne, in the 'Quarterly Journal of the Geological Society' for 1856. Since his description was written he has continued to labour assiduously to collect the fragments, and has been fortunate enough to discover nearly all the parts of this fine species. He has generously placed these fragile specimens in our hands, and presented a series of excellent drawings which were formerly exhibited at the Geological Society. In the paper quoted above the fragments were all considered to belong to the *P. problematicus* of Agassiz, a species for which there is unfortunately very scanty material, but which, as originally described, is a Ludlow Rock species identical with one of the Kington fossils, but not apparently with the principal and largest of them, here described, and which in many respects is very like *P. anglicus*.

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[1] I am at present quite unable to decide the true position of these fragments. (See Woodcut, Figs. 25—27, p. 91.)—H. W.

P. gigas has, in common with the latter species, the open scale-like sculpture on the body-rings, and the thick tubercular scales on their margin; the shape of the *epistome*[1] and head is very similar, but the latter is rounded, and not truncate in front.[2] The penultimate body-ring is wider and has a short keel on the upper surface only (while *P. anglicus* has one on both sides above and below),[3] and the tail-joint or telson appears to be emarginate instead of pointed. But if this character should be deceptive, there can be no doubt of the specific difference, since this joint is furnished with a most remarkable elevated crest or ridge, nearly half an inch high, which is quite absent in the Scotch species.[4]

As the fragments indicate a species of the largest size, the above specific name will not be inappropriate. The size of the chelate antennæ exceeds that of any known species.

There are two species in the Kington beds, *P. gigas* and *P. problematicus*, and it was, of course, possible that some of the parts assigned to the former might belong to the latter species. The subsequent discovery of nearly all the parts of *P. problematicus* shows that in this instance the fragments have been rightly collocated.

Head or *Carapace* (pl. viii, fig. 1, Mem. Geol. Surv., Mon. I).—Nearly semi-oval, convex, the width three inches and three quarters at the broad base, probably greater than the length. The specimen being imperfect behind, the true length is not known, but the portion preserved is three inches and a quarter long. The eyes are very large, three quarters of an inch long, oval, and prominent beyond the margin. They are placed very near the anterior end, and the space between them on the margin is about an inch and three quarters, while between the convex inner edges of the eyes it is about an inch and a half. The anterior border is arched and very slightly angular in front, with a crenulate edge. The sides are convex, their margin not visible. (See Woodcut, fig. 17, p. 81.)

In the centre of the carapace, and forming an equilateral triangle with the eyes, is an elongate tubercle. The general surface appears somewhat rugose (see Woodcut, fig. 17).

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[1] Thoracic plate, not epistome.—H. W.

[2] The head in *Pterygotus anglicus*, Ag., is now known to be rounded in front, not trapezoidal, as was believed to be the case in 1859, when the above description was penned (see *antè*, Part I, p. 36, Pls. I and II).—H. W.

[3] This appears to be an error. In *Pt. anglicus* the penultimate segment is only keeled upon the dorsal surface (see *antè*, Part I, p. 42, fig. 6, Pl. III, fig. 2, and Pl. VIII).—H. W.

[4] The Scotch species is proved to have a well-marked keel to the telson (see Part I, p. 42, Pl. II, fig. 1, and Pl. VI). In Pl. II, fig. 1, the young and perfect Pterygotus there drawn has a high ridge to the telson, which is clearly seen folded down towards the right side of the tail-plate. In Pl. VI it is erect and thickened into a strong keel by reason of the greater age of the individual.—H. W.

Thoracic Plate (formerly called the *Epistoma*, pl. viii, fig. 2, Mem. Geol. Surv., Mon. I).—The proportions of this plate and its sculpture are very like those of *P. anglicus*, and specimens figured indicate this part to be quite as large as in that species. The plicæ on the upper or front portion are crowded, and but slightly curved; those further back are semicircular or even semi-oval, while those near the apex of the side lobes are narrower and pointed as in the cognate species. Similar but smaller plicæ occur down the centre lobe, which does not appear to have prominent elongate scales, nor is it convex as it is in *P. anglicus*. Its base is broad and spear-shaped.

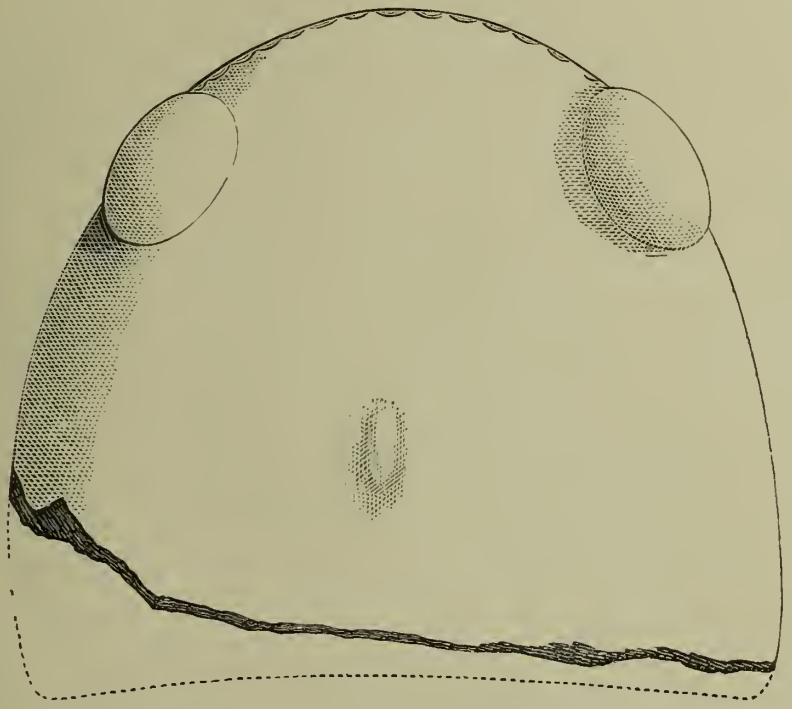

Fig. 17.—Head of *Pterygotus gigas*, Salter. From the Downton Sandstone of Kington, Herefordshire; in the Cabinet of R. Banks, Esq.

Body-rings.—The anterior body-rings (Mem. Geol. Surv., Mon. I, pl. viii, fig. 3), bear the squamæ only on their front half, and these are less curved and less crowded than in the corresponding segments of *P. anglicus*. The edge of the plicæ is thickened. Figs. 4 and 5 (op. cit.) must represent large segments from a portion of the body further back than fig. 3, for the squamæ cover the whole lower surface of the segment (fig. 5), and the greater part of the upper side (fig. 4). They are greatly more convex than in the Scotch species, the posterior ones especially being parabolic or even pointed in form, frequently three tenths of an inch long and equally broad. Fig. 5 (op. cit.) shows the closely squamate lateral edges of the segment, which are convex and rounded in the forward portion and sharply keeled behind. The front margin in both of these segments is contracted, for articulation with the previous joint, and has a broad groove running along its whole length. The hinder angles are a little produced.

Penultimate Segment (figs. 6 to 9, and pl. ix, fig. 15, Mem. Geol. Surv., Mon. I).—This joint is much wider than long, in the proportion of four inches and a half to two inches and a half; some specimens must have been fully five inches long, and, therefore, nine or ten broad. The segment is widest and flattest at the hinder end, the margins are compressed and keeled, except at the thickened and contracted base, and the angle (fig. 9) pointed and produced. The upper surface (fig. 7) is gently convex, but without any ridge, while the lower (?) (fig. 6) has a short thick keel extending half way up. It terminates on the hinder margin of the segment, which is rather deeply notched at this point. The surface is thickly covered with plicæ, both above and below, but they are much more prominent on the lower (keeled) surface[1] than on the other, where they are mere surface markings and often obliterated. They cover the whole of the segment, but are less thickly placed towards the hinder margin, at least on the under side (fig. 6). The margin itself is tubercular.

The squamate keeled lateral borders are ornamented with several (about four or five) rows of oblique thick plicæ, more prominent and larger on the lower side; these are continued from about the anterior fourth of the segment, where the keel commences, to the pointed hinder angle. Similar, but still larger, plicæ cover the central keel, and numerous shallow folds run obliquely backwards from the sides to the keel.

Telson or Tail-joint (pl. ix, figs. 16, 17, Mem. Geol. Surv., Mon. I).—The dimensions of this joint give the best indication of the size to which the species grew; its length was full 5 inches, and the width 4½. The largest specimens of this part in *P. anglicus* (pl. v, fig. 5, op. cit.) are rather longer, but narrower. The general shape was that of a broad and pretty regular oval, but truncated at the base and emarginate at the apex. The under side is flat, except at the origin of the joint, while it is somewhat convex; the median line is even concave. Oblique folds or lines, like those on the penultimate segment, occur on the forward half. The upper side is also flattened, but furnished along its whole length with a great central keel, rather thick at its origin, but becoming narrower and more elevated (six tenths of an inch high in the centre), and then decreasing towards the tip.

Sculpture as in the preceding segment. The blunt ridge of the central keel is covered with small squamate plates, and the margins have four or five rows of oblique elongate ones. The general surface is bare of plicæ, except near the base, where they are numerous and prominent both on the upper and under side.

Appendages.—*Chelate Antennæ* (pl. ix, figs. 1, 3, Mem. Geol. Surv., Mon. I).—Fragments only are yet found; the large base of the fixed claw is about five inches long to the first tooth (in the largest *P. anglicus* it is not more than three inches and a quarter), and one inch ten lines broad (nearly of equal breadth throughout). The articulating edge is long and oblique, the joint narrowing considerably into the serrate claw. Of this portion there is but little preserved, but it shows the chela to have had broad (probably subovate) cutting teeth, as well as numerous close-set smaller ones. These last are short, conical near the base of the fixed claw, and coarsely striated parallel to their sides, the striæ branching from above downwards. Further out (as shown in the specimen, fig. 2, op. cit., which may be the free claw), the smaller teeth are lanceolate and narrow, and the striæ parallel. These striæ are very closely set, much more so than in any other species. The teeth appear to have been irregular in size, and much crowded; a third specimen (fig. 3) shows three kinds, a small lanceolate one, larger subovate secondary ones, and one a great striate tooth, apparently the median one (see pl. vi, fig. 5, op. cit.), which is coarsely ribbed, and is, besides, serrated on the inner edge.

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[1] We have already stated, in a footnote, p. 80, that in *Pterygotus* there is no keel or ridge to the ventral surface of any segment of the body; Mr. Salter's description, given above, must therefore be reversed, and his fig. 7, pl. viii, op. cit., must be regarded as the *under* side of the penultimate segment, and fig. 6 as the *upper* or dorsal surface of the body.—H. W.

The *endognath* has somewhat broader and shorter teeth than that figured in pl. vii (op. cit.), and the second maxillary piece is more curved anteriorly. Both specimens are preserved in Mr. Banks' cabinet.

Of the palpi (pl. ix, figs. 5—7, Mem. Geol. Surv., Mon. I) only fragments are left. Fig. 5 shows four joints connected, but all compressed in a direction perpendicular to their length. Their diameter is half an inch, and their proportions may be compared with those shown in pl. vii, fig. 4 (op. cit.). The second joint is rather longer, and the third not quite so long as in *P. anglicus.* The other figured fragments are less distorted; fig. 6 shows the fourth joint fully one inch and a half long, with the tip expanded and bilobed. In fig. 7 one of the lobes bears a fringe of spines. All the joints show elongate squamæ on their outer side.

Swimming-foot (pl. ix, figs. 4—9, Mem. Geol. Surv., Mon. I). The great basal joint (fig. 8), with its serrated tip, closely resembles in form and sculpture that figured in pl. vii, 'Geol. Surv. Mon.,' the chief difference being the greater width of the foliaceous base, and the more backward position of the notch at the point of attachment for the succeeding joints. The serrate terminal lobe (figs. 4 and 9) has broad stout teeth, as usual, thirteen in number, slightly curved, the uppermost broader and shorter than the rest, the lowest a rounded lobe as broad as the two preceding teeth taken together. The teeth are shorter than in *P. anglicus,* especially the upper ones, so that the outline of the serrate edge is more curved. The perfect specimen is only three inches and a half long by two inches and three quarters broad, but fragments indicate a size equal to the largest specimens of the Scotch species.

Of the other joints of the swimming-foot only two or three specimens (pl ix, figs. 10—12, Mem. Geol. Surv., Mon. I) have occurred. Fig. 10 shows the upper surface of the right-hand swimming-foot, with two complete joints; the fourth and fifth, with a portion of the great penultimate joint. The latter joint is better shown in another fragment (fig. 10), which is in close juxtaposition, and has a fragment of the fifth joint attached to it.

The fourth and fifth joints closely resemble those in *P. anglicus* (see pl. vi, op. cit.), but the form of the penultimate or propodite is, as usual, characteristic. It is oblong, two inches and a half in length by one and a half broad, and is but little broader at one end than the other. The upper or proximal end is deeply bilobed, as in *P.* (now *Eurypterus*) *punctatus,* the lobes being apparently equally prominent, and the distal or outer end is trilobed; this is partly seen in fig. 10, but much better in fig. 11, where the outer lobe is pointed and prominent, the middle one rounded and shallow, and the inner truncate; the last forms nearly a straight line, ending in a sharp angle against the straight inner margin.

Both outer and inner margins of the penultimate joint are serrate, with elongate appressed squamæ, and the surface of the preceding joints (the fourth especially) has close and rather elongate plicæ.

Of the terminal palette there is no trace; its probable shape is given in the dotted outline (by Mr. Salter, in pl. ix, fig. 10, op. cit.).

Only the *metastoma* (pl. ix, fig. 13, Mem. Geol. Surv., Mon. I) remains to be described. It is greatly like that of *P. anglicus* (pl. vi, op. cit.), and chiefly differs in the more contracted base and large open plicæ of the surface. The notch is somewhat deeper. It may have been smooth over the hinder portion (as in pl. xii, fig. 3, op. cit.), which is the same or a closely allied species, and may be noticed here, though possibly it belongs to *P. ludensis,* above described. (See Woodcut below, Fig. 18.)

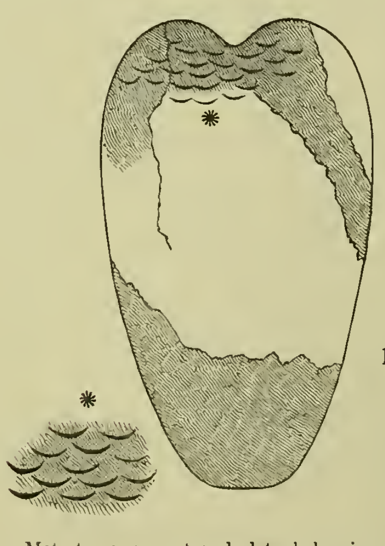

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Fig. 18.—Metastoma, or post-oral plate, belonging either to *Pt. ludensis,* or to *Pt. gigas,* from the "Passage-beds" at Ludlow.

* A part of the sculpture magnified.

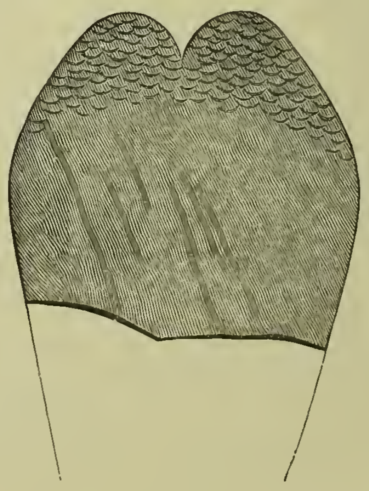

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Fig. 19.—Imperfectly preserved Metastoma referred to *Pt. problematicus,* Upper Ludlow Rock, Ludlow.

This post-oral plate, in its anterior portion, a good deal resembles the fragment figured in pl. ix (op. cit.), the notch being a little less deep only. The shape is much more elongate than in *P. anglicus*, the length being as seven to four; the width is greatest at the anterior third, and the general shape ovate. The plicæ are large and open, and are confined to the anterior portion about the notch.

The basal joint of the swimming-foot (fig. 8), found at the same locality, is in almost every respect like that of *P. gigas*, having the teeth broad and short.

Locality.—Downton Sandstone (Uppermost Ludlow Rock) of Kington, Herefordshire. (Cabinet of Mr. R. Banks, of that place.) Some specimens, presented by that gentleman, are in the Museum of Pract. Geology; as are also specimens collected by Mr. A. Marston, of Ludlow. They were found at the Ludlow Railway Bridge, in the passage beds at the base of the Old Red Sandstone.

Species 8.—PTERYGOTUS PROBLEMATICUS:—Salter.

Pterygotus problematicus, *Agassiz*. In Sil. Syst., 1839, p. 606, pl. iv, figs. 4 and 5 (and 6, tooth of *Sphagodus pristodontus*, Ag., tooth only).
—— —— *Strickland* and *Salter*. Quart. Journ. Geol. Soc., 1852, vol. viii, pl. xxi, figs. 1, 2, p. 386.
—— —— Siluria, 2nd edit., 1856, pl. xix, figs. 4—6.
—— —— „ 3rd ed., 1859, „ p. 265.
—— —— „ 4th ed., 1867, „ p. 237.
—— —— *Salter*. Mem. Geol. Surv., 1859, Mon. I, p. 89, pl. xii, figs. 7—16, 20, 21; and pl. xiv, figs. 16—18.

As this is the principal, if not the only, species in the true Upper Ludlow Rock which has the usual semicircular ornamental plicæ, it is to this that the name *problematicus* should be given; and fortunately, on one of the minute original fragments figured in the 'Silurian System,' the small intermediate plicæ are to be seen marking the species more definitely.

The large chela, figured as above under this name, by the late Mr. Strickland and myself, proves to be really an appendage of this same species, at least it is always associated with it in the same bed. Again, the antennary portions, fragments of body-rings, bases of the swimming-feet, post-oral plate, &c. (pl. xii, Mem. Geol. Surv., Mon. I), are all found in the Whitcliffe, Ludlow, or other localities of the Upper Ludlow Rock, and clearly differ from the corresponding parts in *P.* (now *Eurypterus*) *punctatus*, the only other large species occurring with them, as well as from those just described which are characteristic of the beds of passage above the top of the Ludlow series. *P. problematicus* may now, therefore, be considered an established species, and the cabinets of our Ludlow friends, Messrs. Cocking and Marston, have furnished many of the materials. It occurs, too, in plenty, as Mr. Lightbody's researches show, in the transition beds beneath the Old Red Sandstone (pl. xiv, op. cit.); and Mr. J. Harley, to whom we are indebted for much valuable help, has been fortunate enough to detect its fragments far up in the Cornstones of the Old Red itself, a higher limit than the genus had been known before to attain.

[If the large fragments from the transition beds above quoted, and figured on pl. xiv, Mem. Geol. Surv., Mon. I, be of the same species as the sculpture indicates, the body-segments attained a very large size, nearly three inches from back to front. As it is possible these may belong to a different species, I will describe these portions first.

Carapace (?) (pl. xiv, fig. 16, Mem. Geol. Surv., Mon. I).—A fragment, three inches by two and a half, has the surface sculptured, unlike the body-rings, *i. e.* much more finely marked, and without the regular increase in size and curve of the plicæ backwards. The anterior ones are nearly as much bent as the hinder ones, though smaller; all are but slightly prominent, and are covered by numerous smaller plicæ.

Body-rings (pl. xiv, fig. 17, op. cit.).—One of the broad abdominal rings, two inches and three quarters from back to front; the articulating front margin is rather deeply concave, and its edge is obscurely striated longitudinally. The plicæ are very numerous and close-set, not so large as in *P. anglicus*, or so straight on the forward edge, where, however, they are very closely packed. They are more open posteriorly, and cover more than half the segment, interspersed with very numerous minute semicircular plaits.

Another piece (fig. 14, op. cit.) is here considered as belonging to this species, but it only shows the interspersed plicæ over part of the surface, and it quite possibly belongs to *P. ludensis*, or even to a new species.

Penultimate Joint (pl. xiv, fig. 18, op. cit.) — Of this we have only the lower surface; and as the plicæ are restricted to the upper portions, and only a few small ones are interspersed, it is possibly not *P. problematicus*, but of the same species as the one (fig. 15) mentioned above. The width is greater than that of the same joint in *P. anglicus* or *P. ludensis*, being three inches and a half, while the length is only two and a quarter (or as fourteen to nine), which is about the proportion in *P. gigas*. The joint is not expanded posteriorly, as in that species, and the plicæ are semicircular, not pointed, on the lower side.]

In the true Ludlow Rock but few body-joints have been met with; the two best are figured from Mr. J. Harley's collection, viz. pl. xii, fig. 20, op. cit., must be one of the thoracic rings, and fig. 21 probably the tenth or last but two of the segments. Both show the minute interspersed plicæ very clearly, and these small plicæ extend over nearly all the segment, while the larger ones are confined to the anterior half.

Telson as yet unknown, as also is the thoracic plate.

Antennæ (pl. xii, figs. 7—10, Mem. Geol. Surv., Mon. I).—Fig. 10 is most probably part of the stem, and shows the large and small plicæ in perfection. Figs. 7 to 9 show the large characteristic chelæ, which can scarcely be confounded with those of any other species, the teeth being so much elongated. Fig. 7 is the fixed claw, with a widely expanded and largely dentate base. The shaft is parallel-sided (not tapering as in *P. ludensis*), and the teeth long-lanceolate, the large one being much longer than the diameter of the shaft (in fig. 7, fully three quarters of an inch long); the secondaries, three or four on each side of it, with small teeth interspersed, all linear-lanceolate, erect and remote, not crowded at their bases. In the fixed ramus they are either erect or (fig. 8) point forward a very little.

The striæ on the teeth are very fine and close; somewhat oblique on the great tooth, and more direct in the smaller ones. In *P. gigas* and *P. ludensis* they are coarser, and the teeth broad. The great terminal mucro is as broad and long as the primary tooth, or even longer, and is bent at right angles to the shaft.

Swimming-feet: Basal Joint (pl. xii, figs. 11—14, op. cit.). — Several fragments have been found of the great basal joint, and one tolerably perfect from the Whitcliffe, Ludlow (fig. 11). It shows a wide-expanded basal lobe, and the whole extent of the serrate tip, with the usual number of teeth (thirteen, or rather twelve in this specimen), in fig. 14 the upper tooth being obsolete. Fig. 13 *a*, from Ludlow, shows the full number.

The lobe in front of the teeth is arched and thickened in all the specimens (a character in which this species differs widely from *P. anglicus*), and the second tooth is more than twice the breadth of any of the others, conical, and but little curved; the remaining teeth are long, straight, narrow, and separated by about their width from each other in large specimens. These elongate teeth are very distinctive of the species. I believe I am not mistaken in referring Agassiz's figure of the *Sphagodus* tooth to this portion.

Metastoma (pl. xii, fig. 15, op. cit.) is cordate-ovate, narrower at the bilobed end, and has its greatest width below the middle, becoming angulated at that point. The notch is deep, the lobes rounded (the base is broken off); surface marked with open squamæ, but only near the upper end and about the notch. This post-oral plate is the broadest of any species known.

Fig. 16 is a plate of the same nature as those found with *P. ludensis*, and is possibly a thoracic or abdominal appendage, though, as no species are known with any such attached, its nature is quite doubtful. The entire form is better seen at p. 91 (Woodcut, Fig. 25), viz. a lobed broad emarginate plate (*d*), in the wide notch of which is attached the truncated sub-oval plate, *b*.

Localities.—Upper Ludlow Rock, Whitcliffe, and many places near Ludlow (Ludlow Museum and Museum of Practical Geology, Cabinets of Messrs. Lightbody, Cocking, J. Harley, and A. Marston). Kendal, Westmoreland (Museum of Practical Geology). Ludlow Bone-bed, Ludlow; Downton Sandstone of Bradnor Hill, Kington (Mr. R.

Banks's Cabinet). Base of Old Red Sandstone, Ludlow Railway Station (Museum of Practical Geology). Cornstones of Hopton Gate (Cabinet of Mr. J. Harley).

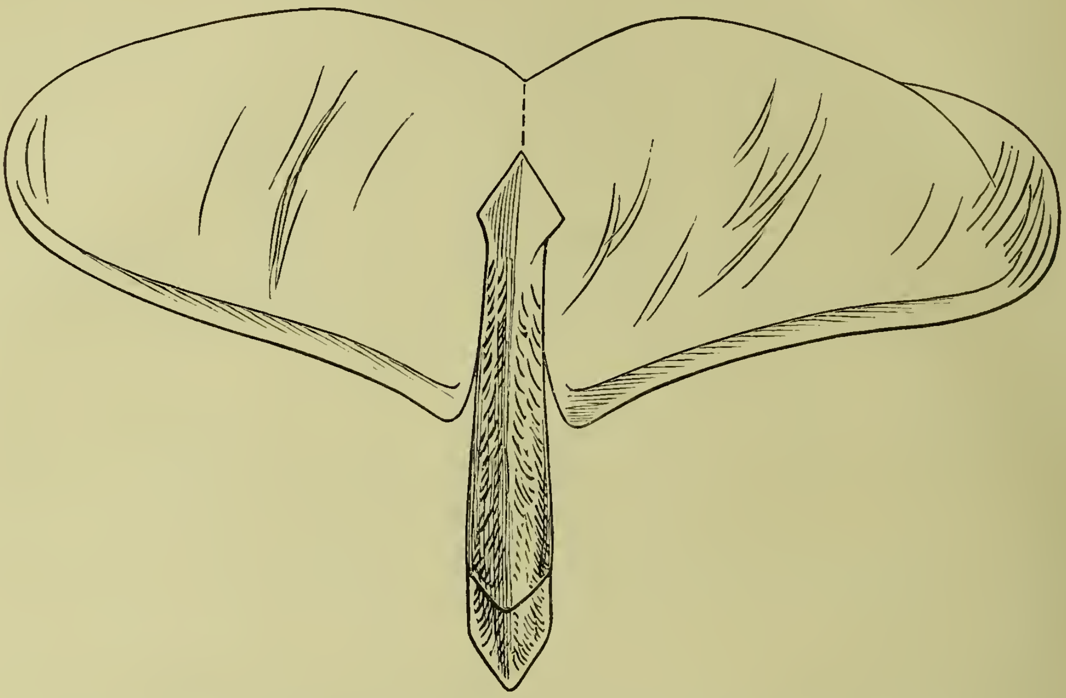


Fig. 20.—Thoracic plate, copied from an unpublished sketch by Mr. J. W. Salter, and referred by him to *Pterygotus problematicus*, Ag. Locality of specimen unknown.

One of the most widely spread species; it is probably this which occurs in the Upper Llandovery Rock or "May Hill Sandstone" of the Obelisk, Eastnor Park.

Several fragments, probably belonging to this species, have been obtained from the Wenlock Shale and Limestone (together with other remains referable to *Eurypterus punctatus*), from Dudley and Malvern, and are preserved in the British Museum, and in the Cabinet of John Gray, Esq., of Hagley, and in those of Messrs. Henry Johnson, E. Hollier, and C. Ketley, of Dudley.

Species 9.—PTERYGOTUS ARCUATUS:—Salter. 1859.

PTERYGOTUS ARCUATUS, *Salter*. Mem. Geol. Surv., 1859, Mon. I, p. 95, pl. xiii, figs. 8, 12, 13, 15, and 16.

This name is applied to a large and fine species, of which several fragments occur in the Lower Ludlow Rock of Leintwardine, with the more common *P.* (now *Eurypterus*) *punctatus*. It is clearly distinct from that species; but, except for the total absence of any minute interspersed plicæ, the body-segments might be easily mistaken for those of

P. problematicus, to which it is closely allied; and with it, in the same beds of Lower Ludlow Rock, occur antennæ, the obscure appendages (figured in our Woodcut, Fig. 25, p. 91), swimming-feet, maxillæ, and other oral apparatus, differing specifically from those of *P. problematicus,* and yet more distinctly separated from the portions of *P.* (now *Eurypterus*) *punctatus* found in the same beds. Of these fragments the body-segment must receive the name, the other pieces being only provisionally arranged with it. They all resemble the corresponding parts in the Upper Ludlow species.

Body-segments (pl. xiii, fig. 12, Mem. Geol. Surv., Mon. I).—This specimen is clearly, from its shape, the second body-segment, seven inches broad and more than one inch and a half deep. It is curved, and more oblique laterally than in *P. anglicus,* the sides forming an angle of 65° with the base. The anterior edge is much more sinuated than the posterior, owing to the deep excavation to receive the first segment; but the central part is strongly arched forward on both margins. The lateral anterior process is broken off, but enough remains to show it was prominent. The sides are oblique, inclined forward at an angle of 80° from the posterior angle, which is rounded off. The margin is crenulated, the prominent minute sculpture confined to the anterior third, but continued more faintly over a large part of the rest of the segment.

A specimen, crushed longitudinally, shows that the species was rotund in section, as in *P.* (now *Eurypterus*) *punctatus* and others.

Antennæ.—In all probability, pl. xiii, fig. 8, Mem. Geol. Surv., Mon. I, represents the antenna of this species. Its resemblance to those of *P. problematicus* is very close. The shaft is linear, the long end turned abruptly up, and the teeth straight, narrow, and remote, as in that species; but the chela is much more slender, three inches and a half to four inches long, and the larger central tooth is scarcely longer than the diameter of the shaft itself, while the secondary teeth, some of them at least, approach it more nearly in size. The tooth at the base of the large terminal mucro is appressed against it, and the mucro itself (pl. xi, fig. 3, op. cit.) is sometimes oblique. All the teeth are finely striate, the striæ tending obliquely backward on the principal teeth. There are numerous sharp, conical, minute teeth between the secondaries.

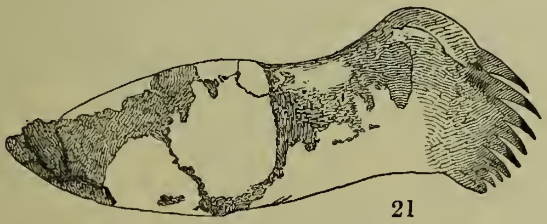


Fig. 21.—The basal joint of an endognath of *Pt. arcuatus,* Salter.

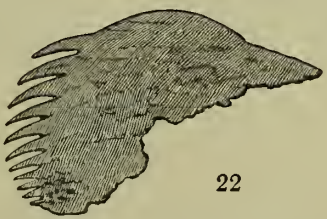


Fig. 22.—Mandibular border of one of the endognaths of *Pt. arcuatus?*

Both specimens from the Lower Ludlow Rock, Leintwardine, Shropshire.

Endognaths.—Most probably, pl. xiii, fig. 15, Mem. Geol. Surv., Mon. I, represents the first or second pair of these organs; and it is pretty clearly referable to *P. arcuatus,* and not to *P.* (now *Eurypterus*) *punctatus,* which has much shorter and blunter mandibles (pl. xi, fig. 6, op. cit.). It is elongate, or even falcate, the upper lobe greatly convex, the posterior portion drawn out laterally instead of backwards; the surface closely sculptured all over. The teeth are not oblique, straight, and conical, as in *P.* (now *Eurypterus*) *punctatus,* but lanceolate and curved, and directed outwards. About ten or eleven are free, the rest confused, either in a horny plate or mixed with setæ. In this particular and in the production of the lower lobe it resembles *P.* (now *Eurypterus*) *punctatus,* but the great curvature and elongation of the plate distinguish it.

Base of Swimming-foot (pl. xi, fig. 10, Mem. Geol. Surv., Mon. I).—Most probably, from the very convex form of the anterior edge, and the greatly elongate teeth, this belongs rather to the present species than to *P.* (now *Eurypterus*) *punctatus.*

Post-oral Plate (pl. xv, fig. 5, Mem. Geol. Surv., Mon. I).—Found at Leintwardine by Mr. Alfred Marston. It differs from the corresponding plate in all the species; having the lobes of the apex narrow, and nearly their own width apart, the sinus between them being very wide and shallow, instead of a simple deep notch. The plate is cordato-lanceolate; for the upper two thirds it is oval, the greatest width being rather below the upper third; the base is rather suddenly contracted, and tongue-shaped.

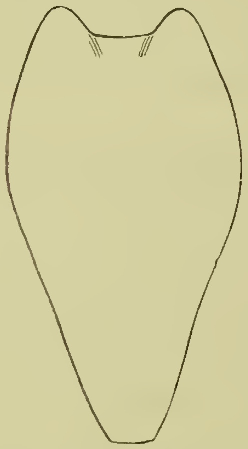


Fig. 23.—Post-oral plate, or metastoma, of *P. arcuatus,* Salt. (Natural size.)

Thoracic (?) *Appendage* (pl. xiii, fig. 16, Mem. Geol. Surv., Mon. I).—This is more perfect than any other specimen, though only the impression of one side. The large ovate terminal plate (*b*) shows well the gradation between the ordinary plicæ and the long lateral plaits; the middle line is bare of any ornament. At the apex are seen two or three of those impressed lines which are so much more conspicuous on the opposite surface, and which seem to divide the plate into laciniæ (*a*). The plate is indented at its basal end, corresponding to the central depression (ridge in the cast) of the preceding joint. This joint is very irregular in shape, the lobes on one side being single, on the opposed side double. Both are marked with minute plicæ near the edges. (See Woodcuts, page 91, Figs. 25—27.)

Locality.—The above-mentioned fragments have all successively come to light during the active researches of the Ludlow geologists in the quarries of Lower Ludlow Rock at Leintwardine, particularly in one at Church Hill. There are many new Crustacea to be described from the same quarry.

Species 10.—PTERYGOTUS (?) STYLOPS :—Salter. 1859.

Pterygotus stylops, *Salter.* Mem. Geol. Survey. Mon. I, 1859, p. 55, pl. xii, fig. 47. (Reproduced in our Woodcut, Fig. 24.)

This remarkable small carapace has occurred to the assiduous search of Mr. R. Banks, of Kington.

Only the anterior part is preserved, and even of this the frontal portion between the eyes is broken off; it was, perhaps, less prominent than the dotted line indicates. The forward position and round form of the great eyes very much assimilate the species to *Sl. acuminata;* but without doubt it belongs to the true *Pterygotus* (near, perhaps, to *Pt. raniceps,* from Lanarkshire, see p. 71).

The eyes are remarkably prominent and turgid, a slightly raised fold of the carapace encircling them. A small tubercle, like that on the same part in *Pterygotus gigas,* occurs on the median line of the head, and rather nearer to each eye than their distance from one another (probably indicating the position of the ocelli). As only a single broken specimen has occurred, it is useless to describe it further. There can be no doubt of the distinctness of the species.

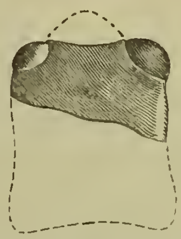
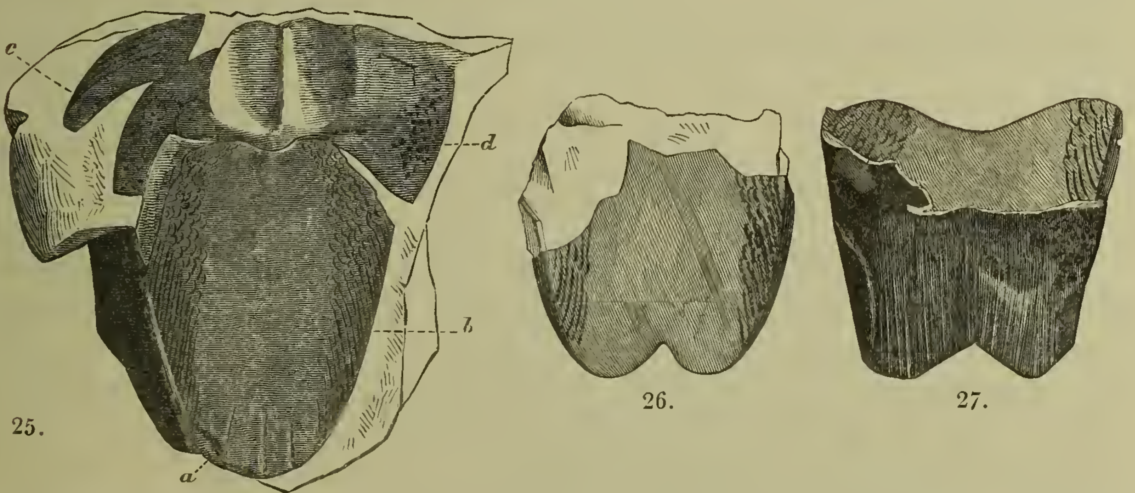


Fig. 24.—Head of *Pterygotus stylops,* Salter.

Locality.—Kington, Herefordshire. Collection of Mr. R. Banks, of Kington.



Figs. 25—27. Crustacean appendages, doubtfully referred by Mr. J. W. Salter to *Pterygotus problematicus, Pt. arcuatus, Pt. ludensis,* or to one of the species common to the Ludlow Rocks. The ornamentation, when preserved, resembles that peculiar to *Pterygotus.* Lower Ludlow Rock, Leintwardine.

NOTES ON SILURIAN LOCALITIES IN THE WEST OF ENGLAND WHERE FOSSIL CRUSTACEA BELONGING TO THE ORDER MEROSTOMATA HAVE BEEN DISCOVERED.

BY THE REV. W. S. SYMONDS, M.A., F.G.S., OF PENDOCK.

(Written to accompany Mr. HENRY WOODWARD'S 'Monograph on British Fossil Crustacea.')

1.—*Pterygotus* OF THE UPPER LLANDOVERY SANDSTONE.

Having been requested by my friend Mr. Henry Woodward, of the British Museum, to give a short description of the principal localities in which those remarkable Crustacea, the *Pterygoti*, *Stylonuri*, and *Eurypteri*, are found in the region of Siluria, I cannot do better than allude, in the first place, to the oldest known form of *Pterygotus*, discovered some years ago by Mr.John Burrow, of Great Malvern, and figured in the 'Memoirs of Hugh Edwin Strickland,' by Sir Wm. Jardine, Bart., under the title of "*Pterygotus problematicus*." It is the jaw-foot only that is preserved. The strata in which the relic was discovered belong to the upper series of the Upper Llandovery beds, where they support the Obelisk in Eastnor Park, near Ledbury, Herefordshire. The common fossils of these strata are the *Nucula Eastnori*, with *Pentameri* and *Stricklandiniæ*. The author of these notes was present with the Malvern Field Club when this oldest known evidence of the existence of *Pterygotus* was discovered.

2.—WENLOCK LIMESTONE AND SHALE.

Although I am tolerably conversant with the *fossils* as well as the physical geology of the Wenlock rock series, it was not until lately that I became acquainted with the fact that remains of *Pterygotus* had been found therein. Mr. Woodward, however, has directed my attention to the occurrence of portions of the body of this Crustacean in a slab of Dudley Limestone in the British Museum. The rock in which these relics occur is undoubtedly the well-known Wenlock Limestone, so celebrated for its Trilobites and Crinoids. The remains occur not only imprinted upon shale attached to the limestone, but, in several instances, in the limestone itself.

The first of these remains, consisting of small fragments only, covered with the characteristic scale-markings, were obtained by Mr. John Gray, of Hagley, and are now in the British Museum.

In the National Collection are also a jaw-foot and several united body-segments of *Pterygotus*,[1] obtained by Mr. Charles Ketley, of Smethwick. Other remains of the same genus are, Mr. Woodward informs me, to be seen in the cabinets of Mr. E. Hollier and Mr. Henry Johnson, of Dudley.

Some of these specimens may be referable to *Pterygotus problematicus*, giving to this species a very wide range in time, as we find its remains in the Upper Llandovery Sandstone, the Wenlock series, the Ludlow rock, and possibly in the Passage-beds.

3.—Aymestry Rock.

The next oldest rock bearing evidence of the existence of *Pterygotus*, that I am aware of, is indicated by the discovery of a "jaw-foot" of *Pterygotus* by myself in the Aymestry rock of Gorstley, near Newent, many years ago. This specimen was forwarded to Sir Roderick Murchison, and is now in the Museum at the College, Great Malvern. This rock is quarried to some extent at Gorstley, and is somewhat remarkable for containing nests of beautiful spicules of the sulphuret of nickel. I have seen the internal casts of *Rhynchonella Wilsoni* filled with these spicules.

4.—Lower Ludlow Rocks.

The next stratified rocks in which we find remains of *Pterygotus*, and also of *Eurypterus*, are the Lower Ludlow beds of Church Hill, Leintwardine. They are shaly beds, which occupy the uppermost strata of this formation, and have furnished the beautiful series of fossil Star-fishes and Crustaceans found by Mr. Lightbody, Mr. Marston, and other geologists. In these strata also was discovered the *Scaphaspis ludensis*, by Mr. John Edward Lee, of Caerleon. This Fish is at present the oldest known form of vertebrate life. We have visited this quarry in company with Mr. Lightbody and Mr. Marston more than once. The section is now nearly destroyed, as the quarry is almost filled up. The remains of *Pterygoti* have been found all through the beds; and in 1865 a new species of *Eurypterus* from them was described by Mr. Henry Woodward.

We were conducted by Mr. Marston to a quarry in a lane called "The Old Road," near to Leintwardine, where the shale is found between masses of the *Pentamerus Knightii* limestone, and where also *Pterygoti* have been found. This *Pentamerus Knightii* limestone is more or less associated at Leintwardine with the uppermost layers of the Lower Ludlow Rock, and is not altogether on the same horizon as the so-called "Aymestry" or

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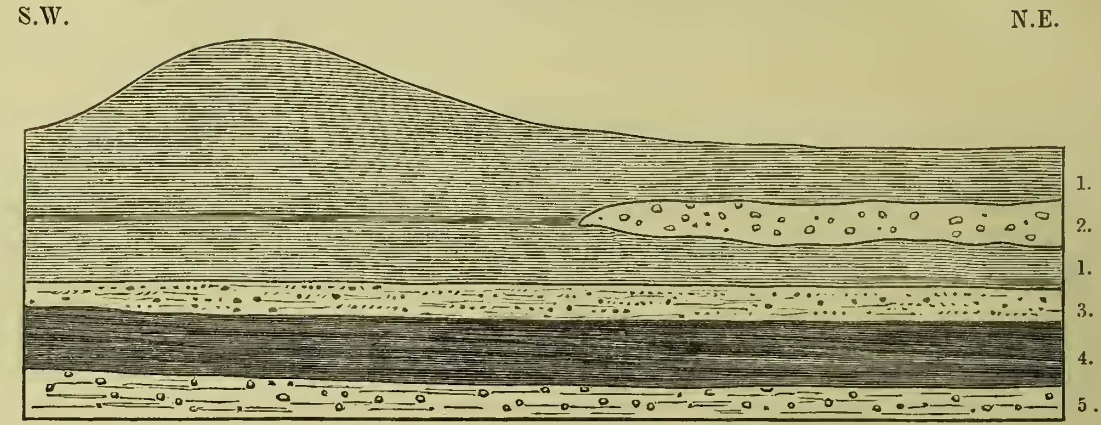
[1] The ornamentation upon these and other portions resembles that figured and described by Mr. Salter as *Pterygotus* (now *Eurypterus*) *punctatus*.—H. W.

Upper Ludlow Limestone of Ledbury and Woolhope. I agree with Mr. Lightbody and Mr. Marston that it should not be considered as a distinct formation, as it is intercalated at different horizons in the Ludlow rocks, both upper and lower.

Fig. 28.—Section of Old Road Quarry (from a sketch by Mr. Marston) at Church Hill, Leintwardine, Shropshire.



1. Shale like Lower Ludlow Shale.
2. Intercalated mass of nodular limestone, with *Pentamerus.*
3. *Pentamerus* bed, about 18 inches in thickness.
4. Shaly bed (about 3 feet thick), with Star-fishes, *Pterygotus,* and *Eurypterus.*
5. Thick bed, with *Pentamerus Knightii.*

5.—Upper Ludlow Rock.

The name of "Seraphim" was given to certain winged-looking bodies (*Pterygotus,* Agassiz) by the Scotch quarrymen who first found them in the Lower Old Red Sandstone of Scotland. In pl. iv, figs. 4, 5, of Murchison's 'Silurian System,' a fragment of the carapace of *Pterygotus* is figured by Agassiz, and he then came to the conclusion that the animal it belonged to must be referred to the class of Fishes, while Hugh Miller, in his 8th chapter of the 'Old Red Sandstone,' gives a graphic account of the after-judgment of Agassiz, and how, in the presence of himself, Sir R. Murchison, and others, "his eye brightened," as he looked upon better specimens of "the huge Crustacean of Balruddery," and he said, turning to the company, "I will tell you what these are,—the remains of a huge lobster!"

It was of the merest fragments of this "Seraphim" from the Upper Ludlow rocks, in the collections of the Rev. T. T. Lewis and Dr. Lloyd, that Agassiz declares, in the 'Silurian System' (chap. xlv, p. 606), these remains belong undoubtedly to the same animal as the "Seraphim" of the Old Red Sandstone of Scotland.

Mr. Hugh Strickland read a paper[1] before the Geological Society in June, 1852, on the occurrence at Hagley, four miles north-east of Hereford, of the Ludlow Bone-bed, "a stratum interesting, not only for its wide extension, as contrasted with its very slight vertical thickness, but also as presenting nearly, if not quite, the earliest known indication of vertebrate life on the surface of our planet."[2] The writer of these notes accompanied Mr. Strickland and Mr. Scobie on the original discovery of this protruded mass of Upper Ludlow rock, which is in close proximity to a trap-dyke at Bartestree, there seen to traverse and alter the Lower Old Red Sandstone. The following is the section, taken from our measurements made on the spot:

	Feet.	Inches.
Old Red Sandstone.—Red clays and marls . . .	12	0
Brownish beds	2	0
Flaggy beds, micaceous	2	0
Downton Beds.—Yellowish sandstones, with carbonized Plants .	2	0
Clay	0	6
Micaceous yellow beds, with Plants	4	0
Bone-bed, with teeth and spines of Fish, and *Pterygotus* . .	0	1
Upper Ludlow Beds.—Numerous fossils and *Pterygotus* claw, in the Strickland Collection at Jardine Hall . . .	4	0

The chelæ of a *Pterygotus* were afterwards discovered by Mr. Scobie in the Upper Ludlow rock at Hagley, and forwarded by him to London, where it was examined by Mr. Salter, and described by him[3] as being especially interesting, and exhibiting the limbs of a Silurian fossil not hitherto discovered. These he connected satisfactorily with the species so fully figured by Agassiz, which was obtained from the basement beds of the Old Red Sandstone of Forfarshire.

On the same slab with it are specimens of *Orthis lunata* and *Orbicula rugata*, fossils of the Upper Ludlow Rock, and not found in the higher, yellow, Downton Sandstones. This *Pterygotus* claw is in the cabinet of Mrs. Hugh Strickland, at Jardine Hall, Dumfriesshire, and is figured, 'Quart. Journ. Geol. Soc.,' vol. viii, pl. xxi, under the name of *Pterygotus problematicus*. The pit at Hagley, though still open, has not been worked for some years; but I well remember having seen fragments of the carapace of *Pterygotus* in the yellow Downton Sandstones which overlie the "Bone-bed." The "Bone-bed," too, of Hagley Quarry is especially rich in Crustacean and Ichthyic remains.

The line of junction between the Passage-rocks of the Old Red Sandstone with the Upper Ludlow rocks strikes in a north-east direction from the Painscastle Hills to Kington, and thence flanks the hills which run by Shobdon and Richards Castle to Ludlow. The Upper Ludlow rock is seen well filled with fossils along Hergest Ridge, and thence by Gladestry to Painscastle, where it is overlain by ridges of the lowest Old Red Sandstone.

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[1] 'Quart. Journ. Geol. Soc.,' vol. viii, p. 381.

[2] Op. cit., vol. ix, p. 8.

[3] Op. cit., vol. viii, p. 386.

These strata furnish occasionally the remains of the carapace of *Pterygotus,* which I have myself seen there in the same slabs with *Platyschisma helicites,* and the characteristic *Chonetes lata.*

At Bradnor Hill, near Kington, the lane which leads to the hill from Newton exposes what I consider to be the summit of the Upper Ludlow rock, and the Bone-bed associated with its upper layers. These beds contain true Upper Ludlow fossils, as *Cornulites serpularius, Platyschisma helicites, Chonetes lata, Rhynchonella nucula, Orbicula rugata*, and *Orthoceratites* of two or three species, and which are not found in the overlying Passage-beds proper. Remains of *Pterygotus* also occur in these strata.

6.—Passage-beds.

The transition- or "Passage-beds" between two great formations often furnish a series of fossils of the highest value to the palæontologist, and the Passage-rocks between the Upper Silurians and the Lower Old Red Sandstone are no exception to this rule. The occurrence of large Crustacea other than *Trilobites* in the older rocks was hardly known until about the year 1855, when discoveries were made in Scotland and Siluria of several new forms of fine Crustacea, which have been described by Salter, Huxley, and more lately by Woodward. In many localities these remains of Crustaceans are accompanied by the relics of Fishes, such as *Pteraspis* (the oldest form of which has been found in the Lower Ludlow beds, below the Aymestry Limestone), *Cephalaspis, Auchenaspis,* and *Onchus,* two of which forms, *Pteraspis* and *Onchus,* range from Silurian deposits into the Middle Old Red, for remains of both these genera have been detected in rocks above the "Cornstones." As, however, the characteristic Silurian shells do not appear in any quantity above the "Bone-bed," for convenience sake I place the base of the "Passage-beds" at the "Bone-bed," inclusive. I include in the "Passage-beds" all the strata from the summit of the Upper Ludlow Rock proper to the micaceous flags and red marls which herald in the Old Red proper, and which contain traces of *Cephalaspis Lyellii* and *Scaphaspis Lloydii,* two Fishes abundant in the overlying Cornstones.

It was in 1854 or the commencement of 1855 that my friend Mr. Richard Banks, of Ridgebourne, Kington, first directed my attention to the remarkable collection of fossils he had obtained from several localities in that neighbourhood. I acquainted Sir R. Murchison with the fact of their discovery, and papers were subsequently published in the Journal of the Geological Society and in the 'Edin. New Phil. Jour.,' by Mr. Banks, Sir P. Egerton, Sir R. Murchison, Mr. Salter, and myself, with descriptions of the fossils and their position in the strata in which they were discovered. (See 'Edin. New Phil. Jour.,' April, 1855, and Oct., 1856. Also 'Quart. Journ. Geol. Soc.,' May, 1856; and March 25, 1857, &c.)

In addition to the discovery of some new forms of Fish, Mr. Banks found the relics of several Crustaceans, such as *Pterygotus* and *Eurypterus*; but on visiting the localities in which the fossils were found on several occasions, I am satisfied that the sites from which they were obtained are all *below* the Upper Ludlow Rock in stratigraphical position.

In strata that are intermediate between the Upper Ludlow Rock and the Yellow Downton Sandstone, Mr. Banks found *Pterygotus* remains associated with *Platyschisma helicites* and a small *Lingula ;* this was between Newton and Bradnor Hill. The overlying strata also contain remains of *Pterygotus* with the *Lingula cornea* of the Downton Sandstones.

At Ivy Chimney is a sandstone quarry low down on Bradnor Hill, which furnished to Dr. Melville, Mr. Lightbody, and myself on one occasion the head of *Eurypterus.* These beds are apparently lower in position than the Downton Sandstone. The Downton Sandstone on Bradnor yields throughout remains of *Pterygotus, Eurypterus,* and *Cyathaspis Banksii,* with *Lingula cornea.* Again, these crustacean remains are found in a quarry at the Lodge Farm, Huntington. New Radnor church is built of Downton Sandstone, from a quarry between New Radnor and Harley, in an interesting outlier of Downton Rock; crustacean remains, with *Lingulæ,* occur in the *débris* which is strewn around.

7.—Passage-beds at Ludlow.

The lowest of the Passage-beds in the section on the Shrewsbury and Hereford Railway, near the Ludlow Tunnel, are beds which are believed to be the equivalents of the Upper Downton Sandstone. The same history attaches to the "Tin Mill Beds," near Downton. *Pterygotus gigas, Pterygotus Banksii,* and *Lingula cornea,* with *Eurypterus linearis,* have been found in these strata. The lower Bone-bed occurs on the right bank of the Teme, near Ludlow; but, owing to a fault or overlap, I believe it has not been found on the left bank near the Ludlow Tunnel. Indeed the Ludlow section will not bear comparison with the Ledbury section (to which we shall allude bye and bye) as regards the perfect continuity of rock-succession. The different beds are much obscured, and their relation to each other was difficult to determine. There is a grey sandstone between Onibury and Norton, and at the Tin Mills near Downton, which I believe to be the equivalent of certain grey grits at Ledbury, and this contains *Cephalaspis Murchisonii* and a *Lingula* at both places, with many carbonaceous remains of Plants.

The Olive Shales described by Mr. Marston ('Geol. Mag.,' 1870, vol. vii, p. 408) overlie these grey micaceous sandstones.

The Olive Shales were excavated on the line of the Shrewsbury and Hereford Railway; and when I visited this locality in company with my friends, Messrs. Lightbody, Salwey, and Marston, they were yielding a rich harvest of organic remains. Mr. Lightbody's cabinet and the Museum at Ludlow are both enriched with rare fossils from these shales. In the middle of these beds was a deposit, termed by my friends an "upper bone-bed,"

Localities.		*Formations.*	*Fossil Contents.*
Near Ludlow, at Boulden, Whitbaitch, and Oakley Park.	Old Red Sandstone.	Lower Cornstones.	*Pteraspis, Scaphaspis, Cephalaspis Lyellii, Zenaspis Salweyi.*
		Micaceous soft red marl beds.	*Pteraspis, Scaphaspis,* and *Cephalaspis.*
		Hard stone.	
Paper Mills.	Passage-beds.	Hard micaceous beds.	
		Olive Shales.	*Cephalaspis Murchisonii, Pterygotus Banksii, Eurypterus* (3 species).
Overbury Ludlow Railway.		Hard micaceous beds.	
		Different coloured thin beds.	*Auchenaspis, Scaphaspis.*
		Red beds.	
Bull Ring, Ludlow.	Upper Silurian.	Greenish-grey micaceous beds with nodules of soft perishable mudstone.	
Onibury, &c.		Downton Sandstone.	*Pterygotus* (scarce). *Eurypterus.* *Pterygotus, Eurypterus.*
Forge Bridge.		Dark-olive stone.	
		Shales.	
		Upper Ludlow beds.[1]	Bone-bed.

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[1] From a section by Mr. Marston, with the exception of placing the demarcation of the Upper Ludlow at the Lower Bone-bed.

which yielded to their hammers no less than three species of fossil Fishes, *Cephalaspis Murchisonii*, *C. ornatus*, and *Auchenaspis Egertoni*, which Sir P. Egerton informs me is a different species of *Auchenaspis* to that found at the Ledbury section outside the Tunnel. At the Tin Mills, in this olive shale, no less than three species of *Eurypterus* were found, together with the *Pterygotus Banksii* of the Kington beds.

Purple grits full of mica succeed these shales at the Tin Mills, and they contain a large *Lingula*.

Over these again rests a grey micaceous sandstone, with *Lingulæ* and carbonaceous markings. These strata are upon nearly the same horizon as the grey *Auchenaspis* grits of Ledbury.

8.—PASSAGE-BEDS AT LEDBURY, HEREFORDSHIRE.

In my paper on these rocks as displayed on the line of railway between Malvern and Ledbury, in and outside the Ledbury tunnel, the following passage occurs:[1]—"In my communication on 'The Old Red Sandstone of Herefordshire,' published in the 'Edinburgh New Phil. Journ.' (April 1, 1859, p. 232), I expressed my opinion that the Ludlow sections on the horizon of the Passage-beds above the Downton Sandstone are broken by faults, and that the true succession is therefore destroyed. I had come to this determination long before the beds now developed in the railroad-cutting at Ledbury were exposed to view; and, having again visited Ludlow, and compared the Passage-rocks of that district with those of Ledbury, I am convinced that nowhere perhaps in the world is there such an exhibition of Passage-beds presented to the eye of the geologist as at the Ledbury Tunnel on the Worcester and Hereford Railway."

I have visited Ludlow on more than one occasion since writing these words, and as I have no reason for altering my opinion, I do not hesitate to reproduce the Ledbury section, marking more especially the beds in which the remains of Crustaceans occurred. It will be sufficient to say here that the section was entire throughout, not being interfered with by any break or obscurity, and was carefully measured off yard by yard and inch by inch. The Aymestry rock, with *Pentamerus Knightii*, was cut through in the Tunnel, and was apparently higher in the Ludlow series than the *Pentamerus Knightii* rock of Leintwardine. Thus we had—1. Aymestry rock (ten feet); 2. Upper Ludlow beds with *Chonetes lata*, &c. (140 feet; Ludlow Bone-bed not detected); 3. Downton sandstone (nine feet), with *Lingulæ* and fragments of carapace of *Pterygotus;* 4. Red and mottled marls and thin sandstones (210 feet), with *Lingulæ* and remains of *Pteraspis;* 5. Grey shales and grits at the tunnel's mouth (eight feet), with *Pterygotus* and *Cephalaspis Murchisonii;* 6. Purple shales and thin sandy beds (thirty-four feet), with a few remains of *Lingulæ;* 7. Grey marl, passing into red and grey marl and bluish-grey rocks (*Auche-*

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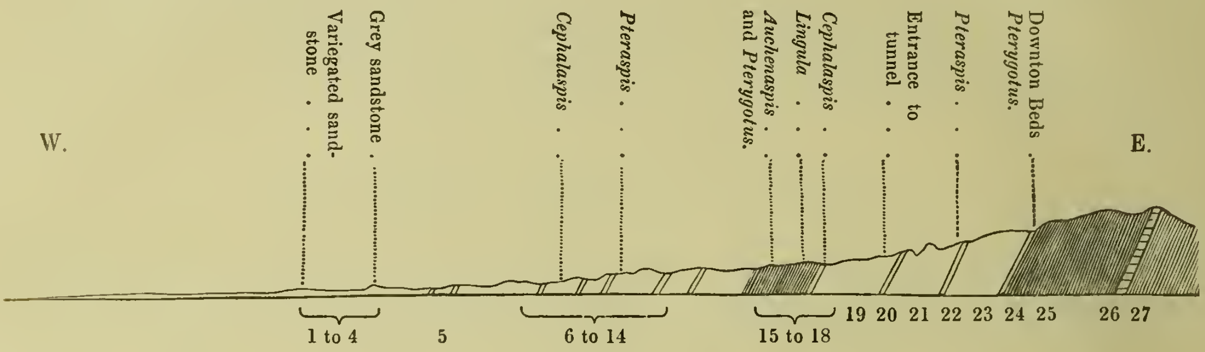
[1] 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 193.

naspis grits, twenty feet), with *Auchenaspis Salteri, Pterygotus, Cephalaspis* (two species), and *Lingulæ.* These strata pass conformably into red marly beds with white and reddish sandstones which yielded fragments of *Pterygotus,* also remains of a *Pteraspis* now in Lord Enniskillen's collection, and a *Cephalaspis.*

Fig. 29.—Section at the Railway Tunnel, near Ledbury, Herefordshire.[1]



Explanation of Section.

1. Marl with some bands of sandstone.
2. Grey rock.
3. Marl.
4. Grey rock.
5. Marl.
6. Grey rock.
7. Marly rock with *Cephalaspis.*
8. Grey rock.
9. Marly rock.
10. Grey rock.
11. Marly rock with *Pteraspis,* some of the hard bands finely laminated.
12. Grey rock.
13. Marl.
14. Grey rock.
15. Marl.
16. Grey marl and Grey rock.
    - Red and blue marls.
    - Yellowish-grey sandstone, 18 inches.
    - Greenish shale, 6 inches.
    - Dark grey sandstone, 8 inches.
    - Deep red micaceous shale.
17. Purple sandstone.
18. Purple marls and shales.
19. Grey shale.
20. Red marl.
21. Red sandstone.
22. Red marl with *Pteraspis.*
23. Mottled marls.
24. Red marls with grey spots.
25. Downton sandstone with red, grey, and yellow marls.
26. Upper Ludlow rocks, about 140 feet.
27. Aymestry rocks, about 10 feet thick.

9.—The Passage-beds of the Woolhope District.

These strata have been well described quite recently by my friend the Rev. P. B. Brodie, in the 'Quart. Journ. Geol. Soc.,' Aug. 1, 1871. The sections nevertheless are poor compared with that at *Ledbury;* and the only one of them worth consideration is that at *Perton,* where we see only 16 feet 11 inches of rock in stratigraphical succession. Mr. Brodie, however, was very successful in finding fossils. In "Olive shales" at the base of the quarry he found *Pterygotus Banksii*, and three species of *Eurypterus*, determined by Mr. Woodward. He also discovered a nearly entire specimen of a new species of *Eurypterus*, named by Mr. Woodward *E. Brodiei*, and described by him before the British Association at Liverpool, 1870.[1] I may here state that these Perton beds rest on the Downton Sandstone proper. I obtained a specimen of the carapace of a *Pterygotus* from yellow sandstone, lying underneath the "olive shales" of Mr. Brodie, and not now exposed. The Perton beds also contain many remains of carbonized Plants, and the seed-vessels regarded by Dr. Hooker[2] as Lycopodiaceous have been found therein. It may interest our readers to state, that the original specimens from which these seeds of land-plants were determined, were found years ago by Mr. Strickland and the writer of these notes, at Gamage Ford,[3] on the south side of the Woolhope anticlinal. The "Bone-bed" is found near Gamage Ford; and from shales closely connected therewith I obtained some beautiful specimens of the shields of *Scaphaspis*, which appear to be the same as *Scaphaspis ludensis* of the Lower Ludlow Rock of Leintwardine. With these two occurred fish-spines and portions of the carapace of *Pterygotus*. The ichthyodorulites are in the cabinet of the Earl of Enniskillen.

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[1] This section was given to illustrate my paper in 'Quart. Journ. Geol. Soc.,' 1860, vol. xvi, p. 194; but unfortunately the engraver did not reverse the drawing, so that the engraving is there reversed. See also 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 154.

10.—Passage-beds at Linley, Salop.

The most northerly extension of the Passage-beds in the Silurian region is probably at Linley, Salop, which I visited in company with the late Mr. George Roberts, who, in conjunction with Mr. John Randall, published a paper thereon in the 'Quarterly Journal of the Geological Society' (1863, vol. xix, p. 229, &c.). Sections along the Linley Brook, four miles north of Bridgenorth, show the positions of the beds. The Coal-measures there rest upon a denuded surface of red Passage-clays, the relics of the denudation of the Old Red Sandstone; and below these we have twenty feet of light-coloured grits, with remains of Plants and fragments of Crustaceans. The whole section through the Old Red clays down to a limestone in the Upper Ludlow is about eighty feet. *Lingula cornea* ranges from the red Passage-beds through the Downton beds down to some shales, with remains of Fishes, Crustaceans, and *Lingulæ*, which I believe to be the representative of the Ludlow Bone-bed. Flaggy beds with *Serpulites longissimus* represent here the Upper Ludlow Shales, which pass into limestone (Aymestry Limestone?). I do not think that any beds at Linley can be correlated with those of Trimpley, near Kidderminster, as was supposed, which are, I believe, higher in the Lower Cornstone series of the Old Red Sandstone, and are not Passage-beds.

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[1] Since figured and described in the 'Quart. Journ. Geol. Soc.' 1871, vol. xxvii, p. 261, with a woodcut. See also Trans. Woolhope Club, 1870, p. 276. Hereford, 1871.

[2] 'Quart. Journ. Geol. Soc.,' vol. ix, p. 12, and vol. xvii, p. 162.

[3] Ibid., vol. ix, p. 9.

11.—Old Red Sandstone (Lower Cornstones), Trimpley, near Kidderminster.

Some years ago I accompanied Mr. George Roberts on an examination of the strata exposed at Trimpley, two miles north-west of Kidderminster. I am not inclined to rank these strata as Passage-beds, as some suppose them to be, but as true Lower Old Red Cornstones. The lowest beds are seen at a place called Little Gayne. They are micaceous shales, and Mr. Roberts showed me a collection of plant remains from these, associated with the egg-packets of the *Pterygotus* (*Parka decipiens*). Portions of the carapace of this Crustacean I saw myself in these flaggy shales. Above these strata there come on, opposite the Church, a series of impure Cornstones, interstratified with greyish flagstones exactly like the beds at Leyster's Pole, near Leominster, and those on the Bromyard Road, north-west of the great Cradley Quarries, near Malvern, which have yielded so many fish-remains to myself and others. These strata at Trimpley afforded numerous remains of *Pterygotus*, *Leptocheles*, *Cephalaspis Lyellii*, *Pteraspis rostratus*, and abundant plant remains. The egg-packets of *Pterygotus* were more numerous than I ever saw them in any other locality.

12.—Old Red Sandstone (Lower Cornstones), near Cradley, Malvern.

I have walked some hundreds of miles in my lifetime in endeavouring to discover a section showing a good passage into these strata, but have not yet succeeded. The ground is always more or less broken by faults, with a brook running on the line of fault, or obscured more or less on the point of junction. I have, however, little doubt that the beds at Trimpley, Leyster's Pole, near Leominster, and on the Bromyard Road near Cradley, are on the same general horizon, that they lie considerably above the Passage-beds proper, and are part and parcel of the Old Red Sandstone, whatever may be the fossils which they and their allied Passage-beds have yielded.

There are, or were, some years ago, two small quarries worked, one on the right and the other on the left of the Bromyard Road (about a mile north-west of the great Cradley quarry, on the summit of the hill, known as 'Cradley quarries'). These quarries are worthy of note. The quarry on the right, or East, which is a little higher in the series than that on the left, or West, has, on several occasions, yielded the remains of *Pterygotus*. The mineral character of this rock is that of greyish flags with impure cornstone concretions. Vegetable remains are nearly as abundant as they are at Trimpley, the beds also contained '*Parka decipiens*.' *Pteraspis*, *Scaphaspis*, and *Cephalaspis* are found here, and it was from this quarry that Mr. Ray Lankester obtained the specimen of

Pteraspis with scales attached, an account of which was communicated by him to the Geological Society in March, 1864 (see Quart. Journ. Geol. Soc., vol. xx, p. 194, &c.).

The quarry West of the road, and opposite the Old Farm House near the East quarry, is lower in the series by a few feet than the other, and the flags and Cornstones therein are full of remains of *Pteraspis, Cephalaspis,* and here and there traces of Crustacean chelæ and portions of carapaces. Specimens of these remains may be seen at the Museum at Worcester, and at the College at Malvern, also in Dr. Grindrod's collection at Townshend House, Malvern.

It is almost impossible to distinguish these beds, as far as carbonaceous markings and mineral aspect goes, from similar beds at Rowlestone, and Cusop, Hay, which are higher in the series of the Old Red Rocks.

13.—OLD RED SANDSTONE (LOWER CORNSTONES), PONTRILAS, AND MONMOUTH CAP, HEREFORDSHIRE.

The Cornstone beds of the Old Red Sandstone commence nearly at the base of that formation, as seen near the railway-cutting at Wall Hills near Ledbury, where their position, as regards the Passage-rocks and Upper Silurians, may be studied. But even here there is a fault across the Passage-beds on the line of the River Leddon, and we have the consequent denudation and obscurity. Ascending upwards we find higher Cornstone groups, interbedded with marls, sandstones, and flagstones.

With no Silurian base to give us a starting point within many miles, we have only fossils to guide us as to the position of the strata exhibited near the Station at Pontrilas on the Hereford and Abergavenny Railway. Years ago, when the railway arch was building at Pontrilas, I saw a portion of a Fish, either *Pteraspis* or *Cephalaspis,* built into the wall; and afterwards my friend Mr. Thackwell and myself obtained fragments and plates of these Fishes and portions of the carapaces of Crustaceans from the loose *débris* in the quarry. Plant remains occur here; and it was from the equivalent beds near Ewyas Harold Castle, I believe, that Dr. McCullough and Mr. Salter obtained the remains of a gigantic *Pterygotus.*[1]

The sections here are difficult to follow out, owing to the lanes, &c., being so much obscured; but a walk from the quarry at Pontrilas Station by the Common of Ewyas Harold will lead the geologist to a Cornstone quarry yielding remains of *Cephalaspis* and *Pteraspis.* When the position of this quarry is compared with that of others on the opposite side of the River Munnow, above Monmouth Cap, and near Grosmont, the geologist will have little doubt that these Cornstone beds overlie the *Pterygotus*- and plant-bearing rocks of the Pontrilas Station.

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[1] *Pterygotus taurinus,* Salter, see pp. 75 and 76 of this Monograph.—H. W.

14.—ROWLESTONE SECTION, AND CUSOP BEDS NEAR HAY. FLAGSTONES OVERLYING THE LOWER CORNSTONES.

The geologist who wishes to study the correlation of these strata should first visit the town of Hay in Breconshire.

In that interesting district the Old Red Sandstone is denuded into lofty hills, with the Wye flowing on the line of denudation between them and the Radnorshire Silurians, upcast on the north and north-east.

Descending downwards from the upper crests of the "Brownstones" of the Black Mountains, and where portions of Old Red conglomerate still linger, we pass from Brownstones into thin Cornstones (Upper Cornstones), in which, only last summer, in company with Mr. Thomas, of Hay, I detected a portion of the dermal plate of a *Scaphaspis.* These Cornstones overlie and pass downwards into greenish and grey sandstones, with beds filled with layers of carbonaceous matter. Years ago speculations were entered into for sinking for coal on the east side of the ravine above Cusop, two miles south of Hay, and much money was sunk in these equivalents of the Rowlestone beds.

Below these flaggy beds (Cusop carbonaceous beds) there are other Cornstones, as seen in the section between Hay and Mouse Castle, and from these Cornstones came the large Fish spine exhibited by myself at the late meeting of the British Association at Edinburgh (1871), and named *Onchus major* by Mr. Etheridge, as being the largest known spine from the Lower Old Red yet discovered.[1] To the north-west of the town of Hay the lower beds of the Old Red with greyish sandstones and carbonaceous remains pass into the Upper Silurians of Radnorshire.

Now, he who examines the Rowlestone district near Pontrilas and Abergavenny, and observes how, as near Hay, Cornstones pass upwards and are overlain by flaggy beds with carbonaceous remains, these flaggy beds always occupying a particular horizon, will have little doubt in correlating the Rowlestone and Cusop flags as belonging to the same rock series, and in concluding that they belong to an upper Cornstone series and not to the lowest. In short, they form a line of demarcation between the Lower Cornstones and the Upper thin Cornstones and Brownstones which are so unfossiliferous throughout all the region of the Old Red of the West of England. On the summit and flanks of Rowlestone Hill, south of Ewyas Harold, Herefordshire, these grey flags have been quarried. They furnished a new species of *Stylonurus* (*St. Symondsii*), which is not unlike *St. Powriei* of the Devonian of Forfarshire, besides other remains of Crustaceans found by Dr. McCullough of Abergavenny, such as *Præarcturus gigas,* Woodward, &c. I have seen Fish remains in strata overlying these Rowlestone Rocks among the Black Mountains, and on the Darren, but the above are the newest relics of Crustaceans in the Old Red proper of which the writer is aware.—W. S. S.

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[1] While staying at Penzance I have seen, in the Geological Museum of the Institute, portions of Fish-spines from the Cornish Polperro beds which are associated with numerous remains of *Scaphaspis* and *Pteraspis,* like *Onchus major* in structure.—W. S. S.

Genus 2.—SLIMONIA, *Page*. 1856.

Species 1.—SLIMONIA ACUMINATA:—Salter, sp., 1855. Plates XVII—XX.

HIMANTOPTERUS ACUMINATUS, *Salter*. Quart. Journ. Geol. Soc. 1855, vol. xii, p. 29, fig. 4.
—— MAXIMUS, *Ib*. Id., p. 28, fig. 3.
SLIMONIA ACUMINATA, *D. Page*. Advanced Text-book, 1856, p. 135, fig. 3.
HIMANTOPTERUS ACUMINATUS, *Ib*. Id., 2nd edition, 1859, p. 163, figs. A. B.
—— —— *Ib*. —— p. 159, fig. 2.
PTERYGOTUS ACUMINATUS, *Salter*. Mem. Geol. Surv., Mon. I., 1859, p. 57, plates ii, xiii, figs. 1—4, xv, fig. 1.
SLIMONIA ACUMINATA, *H. Woodward*, 1863. Intellectual Observer, vol. iv, p. 229, plate and woodcuts.

Slimonia acuminata is the largest species found at Logan Water; and its generic name has been justly given to it in honour of Mr. Robert Slimon, who has, for more than twenty years, laboured most assiduously, at Lesmahago, to perfect our knowledge of this ancient and interesting order of Crustacea.

If we compare the figures of specimens given on Plates XVII to XIX, accompanying this Monograph, with those published in 1859 by Messrs. Huxley and Salter, we shall the better be able to understand and appreciate the vast amount of additional information which we now possess, the result of Mr. Slimon's energetic labours.

Plate XVII represents the most perfect example known; and will serve to convey a very correct idea of the relative proportions and structure of *Slimonia* as compared with the preceding genus *Pterygotus*.

The specimen in this plate has its *ventral* aspect exposed, and, therefore, we do not see the large trapezoidal carapace with its prominent marginal eyes (figured in Plates XVIII and XIX); but we notice the elongated heart-shaped lip-plate or metastoma (*m*) in the centre, covering the buccal cavity; the pair of minute and simple antennæ (2, 2, and detached fig. 3), which in this genus seem to take the place of the great chelate antennæ seen in *Pterygotus* (figured repeatedly in the plates which illustrate Parts I and II of this Monograph); the three pairs of simple many-jointed and spinose endognaths (3, 4, 5, and detached fig. 4); and the great swimming-feet or ectognaths (6, 6) with their broad basal joints serving evidently as powerful jaws; also the thoracic plate or operculum with its tongue-shaped median plate (7, *c*) *in situ*, covering the first and second thoracic rings. The six broad thoracic segments, followed by six narrow abdominal somites, the last four of which are almost quadrangular in form, and terminated by a finely pointed spear-shaped tail-plate or telson, contrast markedly with the more robust and compact body in *Pterygotus*, with its rounded head-shield and great chelate antennæ.

The Head-shield (Pl. XVIII, fig. 2; Pl. XIX, fig. 1) in general form is oblong, the sides slightly swelling for about two thirds of the length, and contracting about the anterior third to again expand slightly at the anterior angles, where the prominent oval eyes are placed (*o*, *o*); the front border is somewhat rounded and, as well as the sides, crenated, or rather tuberculated along the edge.

The posterior border is incurved, and the lateral angles rounded. A kind of double tuberculate border is conspicuous down the sides of the head, the tubercles being elongated, while on the arched front border there are three or four rows. Two short minute keels, one on either side of and close to the median line, mark the hinder border of the head, and are also repeated on the posterior edge of each of the first six body-segments.

The Ocelli.—The two larval eye-spots (ocelli, *l*) are distinctly to be seen near the centre of the head-shield, and about one third of its length from the front border.

The Compound Eyes.—The facets composing the great compound marginal eyes can be not unfrequently clearly seen with a hand magnifying-glass.

Mr. Erxleben has endeavoured to give on Pl. XIX, fig. 2, a representation of the compound eye in *Slimonia*, magnified four times, but the facets are drawn upon rather too large a scale. They measure with the micrometer one tenth of a millimètre each.

Head-shields of *Slimonia* are very numerous both in the British Museum collection and in the Museum of Practical Geology, Jermyn Street.

That on Pl. XIX, fig. 1, measures 5¾ inches in greatest breadth and 6¾ inches in greatest length. That on Pl. XVIII, fig. 2, is 2¾ inches in breadth and 3¼ inches in length.

The head of *Slimonia* was very well known to Mr. Salter at the time of the publication of the 'Geological Survey Monograph,' as appears from the figures given on pl. ii accompanying his description, and from a woodcut in the text at p. 63. Mr. Salter gives an outline of a head measuring 6¼ inches in breadth and 7½ inches in length from the anterior to the posterior border. He does not notice the larval eye-spots on any of the Eurypterida; they have, however, been observed in *Eurypterus remipes* by Professor James Hall, in America.[1]

No ornamentation of any kind has been detected upon the general surface of the head-shield.

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[1] 'Nat. Hist.,' New York, Part iv; 'Palæontology,' vol. iii, plates 80—84, pp. 382—419.

The Body-rings are twelve in number, exclusive of the telson, or tail-plate. Of these the first, or anterior, six are reckoned, as in *Pterygotus* (see Parts I & II), as thoracic, and the remaining six as abdominal somites.[1]

Thoracic Segments.—In these somites the breadth greatly exceeds the length, the fourth segment being nearly six times as broad as it is long.

In the large and very perfect specimens figured on Pl. XVII the proportions of the thoracic segments are as follows :—

	No.	Breadth.		Length.	
1st Segment	(8)[1]	5 inches	by	7	lines.
2nd „	(9)	$5\frac{1}{2}$ „	„	10	„
3rd „	(10)	$5\frac{3}{4}$ „	„	11	„
4th „	(11)	6 „	„	13	„
5th „	(12)	$5\frac{1}{2}$ „	„	12	„
6th „	(13)	$4\frac{1}{2}$ „	„	12	„

The posterior margin of the six anterior segments is ornamented, like the hinder border of the head, with two small keels or ridges upon their dorsal surfaces,[2] one on either side

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[1] These figures *in brackets* will be found to agree with the figures placed against each segment in the plates of this Monograph, and also with the Roman numerals placed upon each segment in the restored figures in Plates VIII and XX.

They are intended to remind the student that the head-shield is not a *simple segment,* but is composed in the Eurypterida of *at least seven* coalesced segments, each represented by a pair of appendages.

The hindmost of these seven coalesced segments, however, bears the opercular plate, as in the modern *Limulus,* and is considered to be equivalent to the first thoracic somite, as in the Xiphosures.

There are then only six *true cephalic somites* remaining in the head-shield of *Pterygotus,* whilst in *Limulus* there are clearly seven. This is explained by assuming that the somite bearing the antennules in *Limulus* is wanting or aborted in *Pterygotus.* (See ante, p. 43.)

Following out this assumption that the antennules were aborted, we have everywhere spoken of the first pair of appendages as the *antennæ.* (See p. 43.) [See also 'Quart. Journ. Geol. Soc.,' 1866, vol. xxiii, p. 33.] The figures and Roman numerals, therefore, express the *actual number* of segments present, which are represented by paired appendages, not the theoretical seven cephalic, and seven thoracic, and seven abdominal segments = twenty-one. (See Introduction, Part I, pp. 4—6.)

The absence of a number corresponding to this assumed aborted segment has inadvertently led to two errata. Thus in the explanation to Plate VIII the segment marked XIV is erroneously classed as thoracic instead of abdominal, and the error is repeated in Part II, pp. 63 and 65, the segment (14) being there also bracketed as thoracic.

In Part I, p. 63, I have said that "in this case" [that is, if we assume that the first thoracic somite is coalesced with the head—then] "only the first six anterior somites will be counted as thoracic, the posterior six will be reckoned as abdominal, and the 'telson' will make up the twenty-one segments."

[2] They are seen as impressions—through the compression of the segments—in the specimen figured in Pl. XVII, which exhibits a *ventral* aspect of *Sl. acuminata ;* but these carinæ are strictly confined to the *dorsal* surface of the segments.

of the median line, each composed of from three to four tubercles arranged in a line, with their blunt points directed backwards. The sides of the anterior segments are rounded and the hinder border but slightly incurved, like the posterior border of the head. A line is usually seen crossing each segment parallel with its anterior border, and indicating the portion of each body-ring inserted beneath that of the preceding segment. At first sight there does not appear to be any trace of the squamate ornamentation, covering the surface of the segments, so characteristic of other members of this sub-order; but, although rarely seen, it may occasionally be detected upon the anterior border of the somites; the plicæ are, however, very minute, and not at all conspicuous as in *Pterygotus anglicus*.

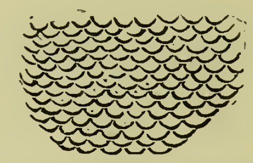

FIG. 30.—Plicæ, greatly magnified, from an abdominal ring in *Slimonia acuminata*, Salter, sp.

The foregoing measurements do not represent by any means the largest-sized body known. A detached body, in which the first six somites (thoracic) are conjoined, preserved in the British Museum, gives the following measurements:—

	No.	Breadth.		Length.
1st Segment	(8)	8½ inches	by	1 inch.
2nd ,,	(9)	8½ ,,	,,	1¼ ,,
3rd ,,	(10)	8¾ ,,	,,	1½ ,,
4th ,,	(11)	8 ,,	,,	1½ ,,
5th ,,	(12)	7¼ ,,	,,	1¼ ,,
6th ,,	(13)	6 ,,	,,	1¼ ,,

Abdominal Segments.—These commence with the fourteenth somite, and, in the specimen figured in Pl. XVII, measure as follows:—

	No.	Breadth.		Length.
7th Segment	(14)[1]	3½ inches	by	1 inch.
8th ,,	(15)	2¾ ,,	,,	1½ ,,
9th ,,	(16)	2 ,,	,,	1½ ,,
10th ,,	(17)	2 ,,	,,	1¾ ,,
11th ,,	(18)	1¾ ,,	,,	2 ,,
12th ,,	(19)	1¾ ,,	,,	2¼ ,,

The sides of these posterior segments are nearly straight; they have no keel-markings, as is the case with the thoracic segments, nor are their borders produced at all.

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[1] See foot-note [1], *ante*, page 107.

The surface of all the segments is much crumpled and creased, clearly indicating that the covering of the body was far less robust than in *Pterygotus anglicus,* Agassiz.

The *Telson* or tail-plate (20) is a large, somewhat oval plate, terminated by a long slender finely pointed spine, often nearly as long as the telson itself. The length without the spine, in fig. 1, Pl. XVII, is three inches, and, including the spine, $5\frac{3}{4}$ inches. The greatest breadth is $2\frac{1}{4}$ inches; the breadth at its articulation with the last segment $1\frac{1}{4}$ inch. The lower side of the telson is somewhat hollowed, whilst upon the dorsal surface it is marked by a strong median keel which is continued down the centre of the tail-spine to its extremity.

The margin of this tail-joint is ornamented with a serrate or tuberculate ornamentation near the base (like that on the margin of the head), which is often seen to be continued down the sides of the terminal spine.

We have already referred to the ocelli and compound eyes which occupy the dorsal aspect of the head-shield; and must now describe those appendages which are grouped around the mouth on the ventral aspect of the body.

The Antennæ (Pl. XVII, figs. 1, 2, 2, and 3; Pl. XVIII, figs. 1, 2, 2). This pair of appendages is very small; and, from the fact of their always lying closely folded down on either side of the mouth, they had remained unnoticed by previous observers until pointed out by me in an account of this genus published in 1863.[1]

The subjoined woodcut (fig. 31) shows the usual position in which they are found. In Pl. XVII, fig. 3, the palpus is turned in the opposite direction with regard to its basal or attached portion (endognath) to that in which it usually occurs.

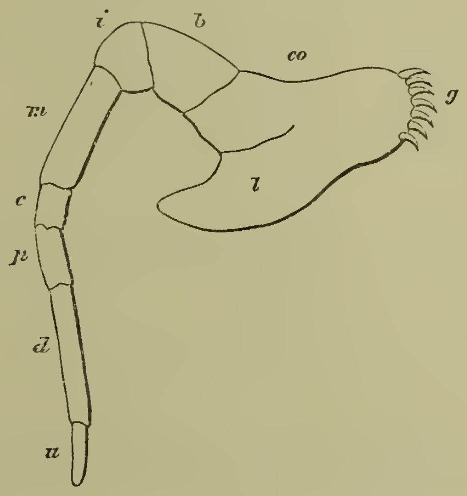

Fig. 31.—Antenna of *Slimonia acuminata,* Salter, sp. (Natural size).

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[1] See 'Intellectual Observer,' vol. iv, 1863, pp. 229—237; woodcut K, p. 235.

The first or coxal joint (*co*) is the largest, measuring 9 lines in its greatest length and 9 lines in its greatest breadth. The tongue-shaped extension (*l*) unites it to the head and to the muscles by which the palpus (*b*—*u*) and the endognath (*g*) are moved.

The mandibular portion (*g*) is armed with from 7 to 8 sharp and recurved teeth about 1 line in length. From the upper side of the endognath the palpus takes its rise: (*b*) the *basos* measures 6 lines in length and four lines in breadth: (*i*) the *ischium* commences 4 lines in breadth, but contracts to 2 lines at its distal end; it is 3 lines in length: the four succeeding joints are nearly cylindrical in form: (*m*) the *meros* is 8 lines in length and 2 lines in breadth: (*c*) the *carpus* is 3 lines in length and 2 broad: (*p*) the *propodos* is 4 lines long and 1½ broad: (*d*) the *dactylus* is 9 lines long and 1 line broad: (*u*) the *unguis* or terminal joint is 4 lines long and 1 line broad.

The structure of this pair of appendages differs widely from the antennæ in the preceding genus (see Parts I & II), and seems to indicate a close affinity with *Eurypterus* (to be presently described).

Instead of the powerful chelate appendages with which the front of the head in *Pterygotus* was armed, we find in *Slimonia* only this pair of minute and simple eight-jointed antennæ which could merely have served as feelers (and accessory endognaths), not as organs of prehension.

Another essential point of difference to be noted in these organs as compared with those of *Pterygotus* is in the fact that the chelate organs in *Pterygotus* do not perform the functions of manducation with their basal joint, but only subserve the purposes of prehension, and to convey food to the mouth, being placed in front of the buccal orifice.

In *Slimonia* the small slender antennæ are expanded at their base so as to form an additional pair of jaws (endognaths), and are, therefore, directly in relation with the buccal orifice.

These distinctions are of the highest importance in considering which of the two pairs of antennary organs has been suppressed in the Eurypterida.

If we take *Pterygotus* by itself, the fact of its antennæ not being furnished with a mandibular basal joint would lead to the inference that these great chelate organs of prehension were equivalent to the *antennules* in *Limulus*, and that the antennæ were suppressed.

If, on the contrary, we take *Slimonia* by itself, the fact of its antennæ being furnished with maxillated basal joints would favour the inference that they were equivalent to the *antennæ* in *Limulus*, and that the antennules were suppressed.

But we so frequently find the same pair of organs in closely allied families, and even genera, of living Crustacea so greatly modified as to present scarcely a character in common save their corresponding position, that we may well suppose the differences of form and office above described to be due, not to a difference in the organs, but to diversity of habits in the genera; suggesting the more actively predacious character of *Pterygotus* as compared with *Slimonia*, and probably that the food of the former consisted of quick-swimming fishes and cephalopods, whilst the latter preyed upon minute or sedentary animals, or was possibly a carrion-feeder, like so many of its representatives at the present day.

If we really knew such to be the actual function required to be performed in each case, the organs in question could hardly be better adapted for their respective tasks.

Endognaths (= Mandibles and Maxillæ) (Pl. XVII, figs. 1, 3, 4, 5, fig. 4; and Pl. XVIII, figs. 1, 3, 4, 5).—Following next after the antennæ we find three pairs of endognaths, with a pair of eight-jointed palpi to each. There is a very good woodcut (fig. 7) of one of these on p. 62 of the Survey Memoir on *Pterygotus*, and upon p. 63 of the same work is a woodcut of a head with parts of two of the palpi preserved nearly *in sitû*.

We figure a large detached endognath on Pl. XVII, fig. 4, the palpus of which measures four inches in length.

The *coxa* or basal joint (*co*) is roughly quadrangular in outline, and is 1½ inches in both length and breadth; the inner border (*g*) is 8 lines broad and is armed with about fourteen sharp and curved teeth, which at the upper end are nearly 2 lines in length, but diminish rapidly to the lower part of the mandible, where they are little more than bristles (as in the endognath of *Limulus*); the lower border (*b*) is nearly square, but half an inch narrower than the upper border; by it the appendage was attached to the head; a few scattered scale-markings are disposed over the upper free border.

The *palpus* (*b-u*) in this specimen seems to be turned the reverse way; it lies with its spiny border downwards and its point directed outwards; usually its upper border is spinose and the recurved terminal spine is directed inwards, as in the accompanying woodcut, fig. 32, p. 112.

The *basos* (*b*) is an oblong joint one inch in length and three quarters of an inch broad; it has a few scale-markings on its upper border.

The *ischium* (*i*) measures one inch along its longest border, but only half an inch along its spinose upper border, being sharply bent upwards; it is three quarters of an inch broad.

The *meros* (*m*) is three quarters of an inch long and the same broad; its distal end and that of the four succeeding articulations is fringed with spines.

The *carpus* (*c*) is three quarters of an inch long and seven lines broad.

The *propodos* (*p*) is five lines long and six broad.

The *dactylus* (*d*) is three lines long and four broad.

Between this joint and the terminal claw (*u*) there is a small joint (*t*) two lines long and four broad (seen also in the woodcut, fig. 32, p. 112); the claw (*u*) is half an inch long, and strongly recurved.

The accompanying woodcut (fig. 32, p. 112) represents the largest endognathary palpus with which I am acquainted. It measures seven inches in length and two inches in greatest breadth. The five distal joints appear to have been fringed with spines at their lower and outer borders, which are more sharply pointed near the extremity. The form and proportion of the five distal joints agree very closely with those in the palpus drawn on Pl. XVII, fig. 4; but the *ischium* and *basos* differ considerably, and appear to be squeezed together. The same squamate markings are seen on the surface. (See Woodcut, fig. 32.)

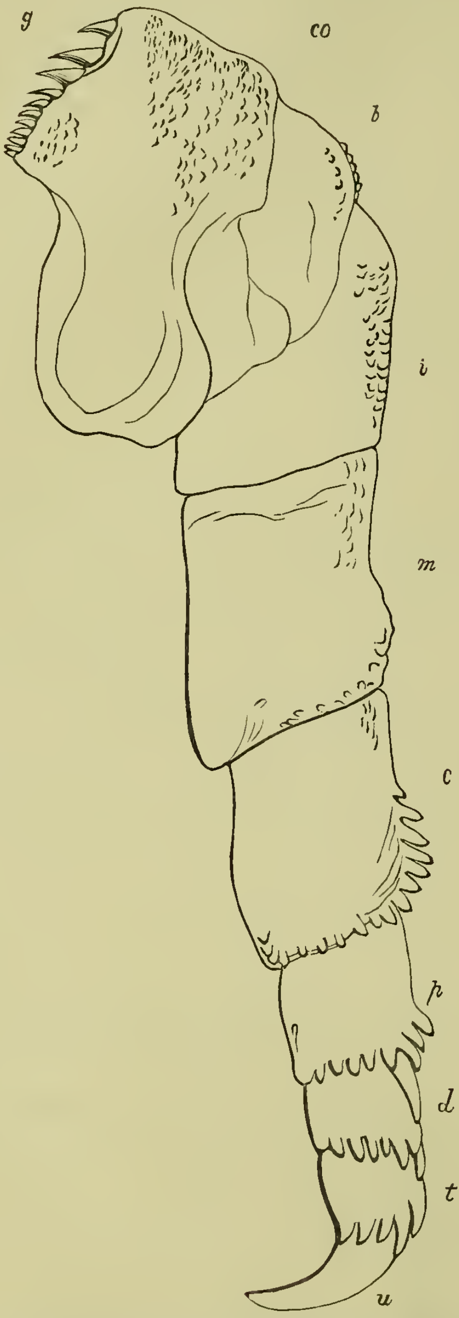

Fig. 32.—Endognathary palpus of *Slimonia* (natural size), U. Silurian, Lesmahagow, Lanarkshire. Original specimen in the Britisih Museum.

These mouth-appendages appear to be much more robust than in *Pterygotus,* and must have served, not only as powerful jaws, but also to retain and bring within reach of the mandibles the living or dead substances to be devoured.

Swimming-feet (Ectognaths) (Pl. XVII, figs. 1, 6, 6, and Pl. XVIII, figs. 1, 6, 6).—The largest swimming-foot of this species with which I am acquainted is a detached example in the British Museum. This specimen measures ten inches from the crest of the maxilla to the terminal palette, the swimming-foot itself measuring six inches in length. The position and form of these organs are well seen, *in sitú,* in Pl. XVII, fig. 1, and in the detached appendages figured on Pl. XVIII, fig. 1.

Coxa.—This joint in form may be roughly compared to a right-angled triangle, the inner or mandibular border and the base forming the rectangle. The base measures $2\frac{1}{2}$ inches in breadth, to the outer angle of which the great swimming-foot is seen to be attached, the outer and longest side of the triangle measuring $4\frac{1}{2}$ inches; the upper end, which forms the mandible, is contracted three inches from the base, where it measures only ten lines in breadth; the mandibular border is $1\frac{1}{4}$ lines broad, and beset with 14 nearly equal-sized teeth one line in length. Some minute squamæ are observable upon the surface of this joint.

Basos.—This is a small segment, four lines only in length, inserted at its proximal end into the external angle of the coxal joint, where it is nine lines broad and expanding laterally at its distal end to 1¼ inches, so as to embrace in its cup-shaped and rounded lower border the conjoined *ischium* and *meros*.

The *Ischium* and *Meros* resemble an oblong square divided diagonally, the *ischium* having its upper and proximal border 11 lines broad, and its lower end cut off by the distal termination of the meros, which is one inch broad, whilst the proximal end of the meros is in like manner cut off by its union with the *ischium*.

The *ischium* along its inner longitudinal free border measures one inch; the *meros* along its outer rounded free border measures 1½ inches; the conjoined border measures 16 lines in length.

The *carpus* resembles the *basos* in form; it is ten lines broad at the upper and five lines long and slightly expanded at the lower border, which is curved so as to afford a better articulation to the *propodos*.

The *propodos* is two inches long and ten lines broad, and its sides are nearly parallel; it is excavated at the lower extremity, so as to admit the insertion of the *dactylus*.

Between these two on the inner side is a small triangular plate intercalated, four lines in length and three in breadth; a similar plate is known to exist in *Eurypterus* and other forms.

The *dactylus* is 1½ inches long and half an inch broad; near its termination a minute plate (*unguis*) is inserted; a similar terminal plate is noticed by Professor Hall in *Eurypterus*. The border of these joints is sometimes seen to be slightly crenated.

Post-oral Plate or *Metastoma* (Pl. XVII, fig. 1, *m*; Pl. XVIII, fig. 1, *m*).—This plate is seen *in sitû* in Pls. XVII and XVIII; the largest lip-plate of *Slimonia* known is that figured in the subjoined woodcut (fig. 33) of the natural size. It measures 5½ inches in length and 1¾ inches in greatest breadth, the lower part being only ten lines broad. Its greater length as compared to its breadth distinguishes it at once from the metastoma of *Pterogotus*, with the remains of which *Slimonia* is commonly found associated.

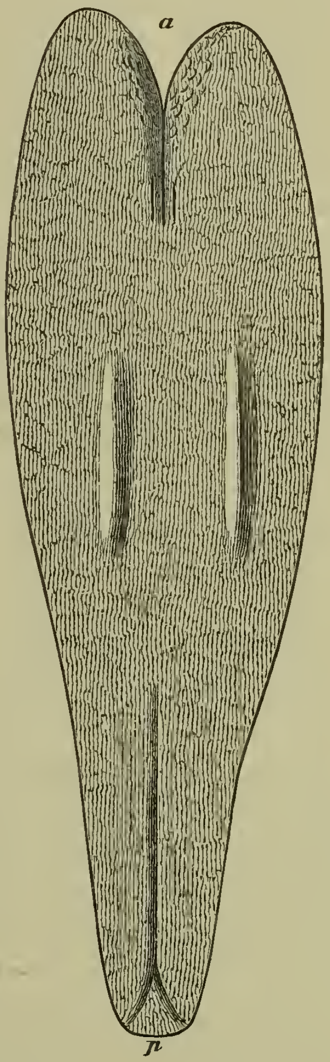

Fig. 33.—Largest lip-plate of *Slimonia acuminata* known, from Upper Ludlow Rock, Lesmahagow. Original preserved in the British Museum.

The upper end (*a*) is deeply bilobed, the lobes elliptical and the notch very narrow; its greatest breadth (1¾ in.) is in the centre of the upper two thirds; the lower third is very narrow and has a raised keel down the centre, two inches long, which bifurcates at the hinder border. Near the centre of the widest part are two subcentral parallel ridges about 1½ inches long. A few scale-like markings are seen near the upper notched end of the lip-plate. This plate was, no doubt, attached along the line of the posterior median ridge and by its hinder border (*p*). It overlapped the inner borders of the great basal ectognaths, and served as a *mentum*, or lower lip, being attached behind, not in front of the buccal orifice, as is the hypostome in the Trilobita.

The Thoracic Plate or Operculum (Pl. XVII, fig. 1, 7, *c*, and fig. 2; and Pl. XX, figs. 2, 3, & 4).—The displacement of this plate in the description of this species by Mr. Salter ('Geol. Surv. Mem.,' Mon. I, p. 59), where, as in the descriptions of *Pterygotus*, it is called "the conjoined epistoma and labrum," has already been referred to under *Pterygotus*. (See restoration after Mr. Salter, Part I of this Monograph, p. 27 and p. 39.) It is only necessary to point out that fig. 5, p. 59, of Mr. Salter's description (op. cit.) is identical in form with the plate seen *in sitû* on our Pl. XVII, fig. 1, 7, *c*; and that figured on p. 60, fig. 6 (op. cit.) is the tricuspid median appendage of a plate identical in form with that figured on our Pl. XVII, fig. 2, and is known to occupy the same relative position in the body of *Slimonia* as that seen *in sitû* (7, *c*) on the same plate in fig. 1. It is, in fact, homologous with the *operculum* of *Limulus* (Part I, Pl. IX, fig. 1, 8, and fig. 1, *c*), and is composed, as in *Limulus*, of the modified appendages belonging to the first thoracic somite, which in both *Limulus* and *Slimonia* is coalesced with the cephalon.

The thoracic plate seen *in sitû* in fig. 1, Pl. XVII, measures five inches from border to border, and is 1½ inches in length; it is divided into two lateral oblong pieces by a median lobe (*c*), which is 2¼ inches long and projects considerably below the rest of the lower free border of the plate. This median lobe in fig. 1 is broadest at its lower rounded extremity, where it is eight lines wide, contracting to six lines where it unites with the two oblong lateral pieces of the *operculum;* at its upper end it forms a small triangle, four lines long and four broad, from the apex of which a narrow double line extends to the upper attached border. Two diagonal lines take their rise from the upper triangular end of the median lobe (*c*), uniting with the upper border of the operculum one inch on either side of its central line.

The specimen figured on Pl. XVII, fig. 2, measures eight inches in breadth and 1¾ inches in length; the median lobe is 3½ inches long; its termination (*c*), instead of being rounded, as in fig. 1, is tricuspid, measuring one inch across the side cusps; the centre of the median lobe is ridged; the margins are slightly curved, and unite in a lanceolate termination half an inch from the anterior attached border. Instead of the two diagonal lines seen in fig. 1, three lateral lines are given off from near the lanceolate upper end of the median lobe, which, expanding on either side, reunite with each other, and so with the upper and inner attached border of the operculum one inch on either side the median line. A slight double border two lines broad surrounds the free margin of the lateral lobes of the operculum.

There is good reason to believe that both these forms of opercular plates not only belong to *Slimonia*, but to one species, namely, *Slimonia acuminata.*

How, then, can we explain the diversity in the form of the median appendage in the two opercula figured on Plate XVII?

If we refer again to its living analogue, *Limulus*, we shall find that in the Moluccan and American king-crabs the same parts are modified in the males of both species, namely, the antennæ and the median articulated appendages of the thoracic plate or operculum (see Pl. IX and Woodcuts, I, II, fig. 34), corresponding to the coalesced median appendage in *Slimonia.*[1]

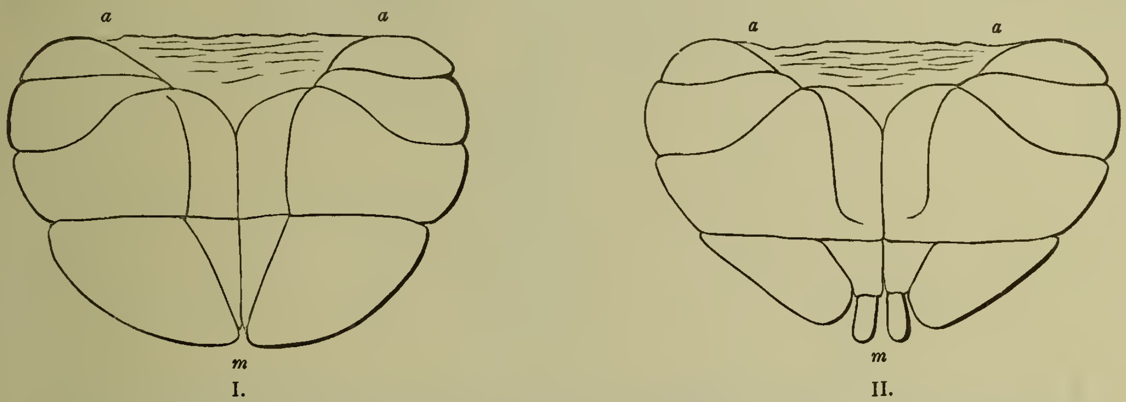

Fig. 34.—Operculum or thoracic plate of *Limulus polyphemus*, Linn. (living). I. Male. II. Female. *a, a.* Anterior attached border: *m* = median appendage.

At present we only know one form of antennæ in *Slimonia*, but the discovery of the two forms of thoracic plate (Pl. XVII, fig. 1, 7 *c*, and fig. 2; and Pl. XX, figs. 3 and 4) affords strong grounds for assuming that we have here evidence of the male and female of this fossil type.

The Branchiæ (Pl. XIX, figs. 3, 4).—In my account of *Pterygotus bilobus*, Salter, in Part II of this Monograph (pp. 66—68, Pl. XI, fig. 2; Pl. XII, figs. 1 *a*, 1 *d;* Pl. XIII, fig. 1 *h*) I have figured and described the branchial plates belonging to that species. Similar leaf-like organs of a larger size have been obtained at Lesmahagow, associated with *Slimonia*, some of which I figure on Pl. XIX, figs. 3, 4, of the natural size. They appear to be arranged in linear series, and were attached in single or double rows to the under surface of the body by their upper end, whilst their lateral and lower rounded leaf-like borders were freely bathed in the fluid medium in order to oxygenate the blood.

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[1] This median lobe is even more readily identified with *Limulus* if we take *Eurypterus* instead of *Slimonia* for comparison. In *Eurypterus* the division of the median lobe into two detached articulated appendages remains clearly visible, whereas in the other fossil genera these are coalesced.

This coalesced median appendage, with its broad lateral alæ, forming together the operculum, is really only the modified pair of appendages belonging to the first thoracic somite, the median pair of appendages (or coalesced lobe, as the case may be) corresponding to the endopodites, and the external alæ to the exopodites of an ordinary pair of Crustacean limbs.

This singularly modified pair of thoracic appendages perform the same office in *Limulus* as do the antepenultimate thoracic legs in the female lobster, or the last thoracic limb on each side in the male; in the former bearing the *oviducts*, in the latter the *vas deferens.*

These leaf-like appendages are highly vascular; they are about two inches in length and three fourths of an inch broad, but they vary in size, having probably been largest near the centre of the body, becoming smaller as they approached the sides.

In the adult living *Limulus* we find the operculum, or thoracic plate, takes its rise from, and is attached to, the posterior margin of the head-shield.[1] This plate bears on its upper and inner surface the reproductive organs, or ovaries, and is succeeded by five similar but more membranous plates bearing the branchiæ upon their inner surfaces. These five branchial plates are nearly hidden beneath the operculum when closely compressed. Each plate, however, represents the modified pair of appendages belonging to a corresponding thoracic somite.

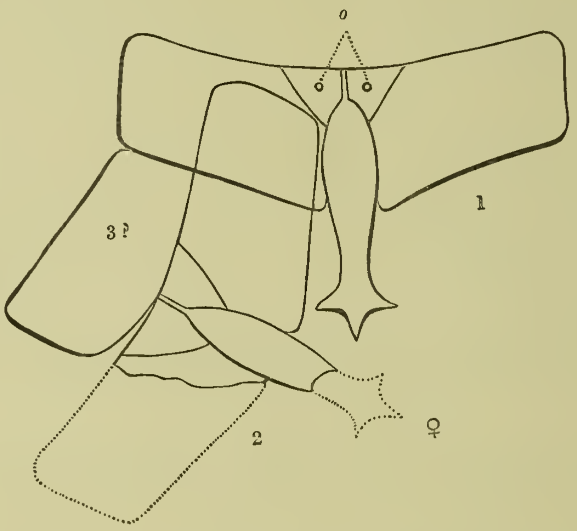

Fig. 35.—Opercula or thoracic plates of *Slimonia acuminata*, Salter, sp., found associated together.
1. The outer or *true operculum*, bearing the ovaries (*o*). 2. First branchigerous plate underlying 1, but now displaced.
3 ? Part of a third plate ?
Mr. Slimon considered this tricuspid form of plate to belong to the *female* of *Slimonia* because he has several times found it associated with masses of the eggs (called by Dr. Fleming *Parka decipiens*).

In *Pterygotus* and *Slimonia* we find the thoracic plate, or operculum, occupying the same position as in *Limulus*, and attached to the hinder border of the head. But as the segments in the Eurypteridæ are not coalesced as in the modern *Limulus*, but are well developed, the thoracic plate can therefore only cover and conceal the two first thoracic somites.

Supposing each of these (marked viii and ix in Pl. XX) to have borne a single or double row of branchiæ supported on two similar but more membranous plates, they might easily have lain concealed beneath the outer operculum.

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[1] With which the first thoracic segment is coalesced. This is also the case in *Pterygotus*, *Slimonia*, &c.

This latter point seems established on the evidence of specimens both in the Museum of Practical Geology and in the British Museum, showing *two* (or three ?) opercular plates of the same shape associated together, and evidently belonging to the same individual.[1]

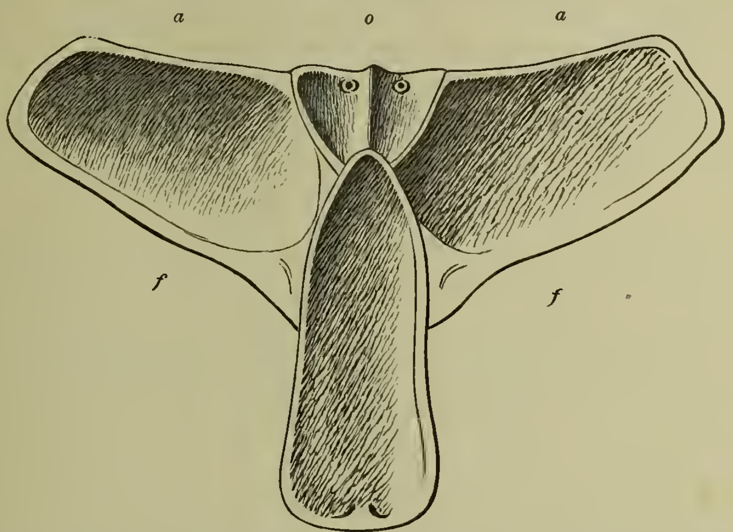

Fig. 36.—View of the inner side of an opercular plate of *Slimonia acuminata,* from Lesmahagow, Lanarkshire, in which the two reproductive openings are seen near the centre of the upper attached border (*a, a*) of the plate.

Two of these plates, moreover, exhibit two small rounded prominences, which, there can be little doubt, were ovarian openings. (See Woodcuts, figs. 35 and 36.)

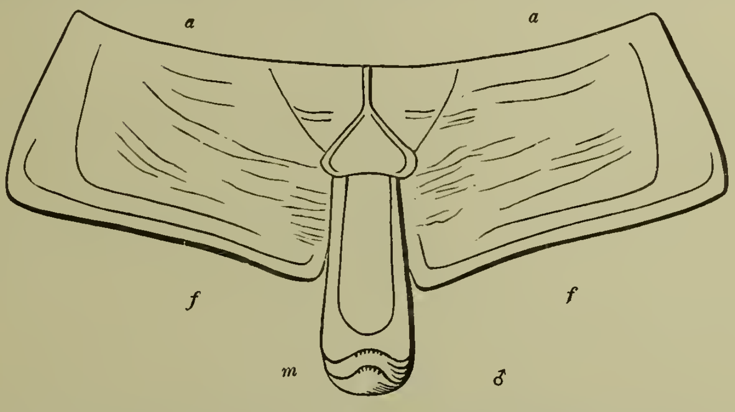

Fig. 37.—Thoracic plate or operculum of *Slimonia* ———— sp. ?, giving indication of the presence of branchigerous plates concealed beneath. *a, a.* Attached border. *f, f.* Free border. *m.* Median appendage.

This paucity in the number of pairs of appendages to the body-rings is a truly larval character, reminding one of the condition of the larval Decapod (see Part I, Plate IX, figs. 6 & 7), and of the still nearer larval *Limulus,* which, in its earlier stage, has appendages only to three of the thoracic somites.[1]

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[1] See 'Quart. Journ. Geol. Soc.,' 1867, vol. xxiii, p. 31. H. Woodward, "On the Structure of the Xiphosura and their Relationship with the Eurypteridæ."

In the two annexed diagram-figures of specimens preserved in the Museum of Practical Geology (figs. 37 and 38) the thoracic plate differs somewhat in form from that usually

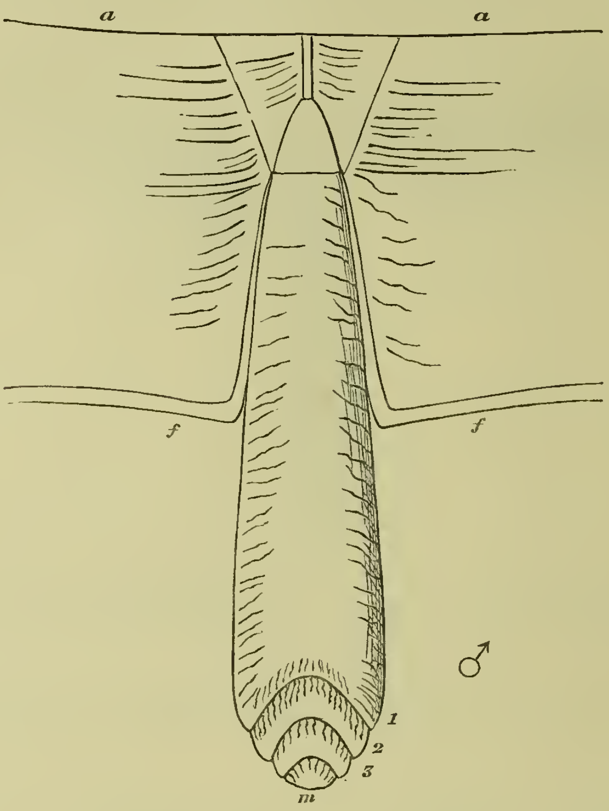

Fig. 38.—Thoracic plate or operculum—part of an almost entire specimen—of *Slimonia acuminata* (only the centre of operculum drawn), showing apparently three plates overlying each other. Length of alæ, 3 inches. Length of median appendage, 5 inches.

associated with *Slimonia acuminata;* they deserve to be recorded, therefore, on that account; but they also appear to give evidence that they conceal beneath them one or more branchigerous plates, the edges of which are seen at *m,* and along the lower border of the lateral alæ of the operculum (*f, f*).

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[1] See 'Quart. Journ. Geol. Soc.,' 1867, vol. xxiii, p. 34. Also 'Sur le développement des *Limules,*' par H. Milne-Edwards, Société Philomathique, Nov. 10th, 1838. On "The Horsefoot Crab," by the Rev. S. Lockwood, Ph.D., in 'American Naturalist,' vol. iv, 1870, p. 257. Also Dr. A. S. Packard, junr., 'On the Development of the "King Crab," *Limulus polyphemus,*' read before American Association for the Advancement of Science, 1870, 'Geol. Mag.,' 1870, vol. vii, p. 491. 'Untersuchungen über Bau und Entwickelung der Arthropoden zur Embryologie und Morphologie des *Limulus polyphemus,*' von Dr. Anton Dohrn. Abdruck aus der 'Jenaischen Zeitschrift,' Band vi, Heft 4. (Received 30th September, 1871.—H. W.) And "Further Remarks on the Relationship of the Xiphosura to the Eurypterida and to the Trilobita," by H. Woodward, 'Quart. Journ. Geol. Soc.,' 1872, Part I, vol. xxviii, p. 46.

One other point which may be mentioned as favouring the conclusion we have arrived at, namely, that there were *at least two* thoracic plates, the one attached to the first thoracic segment coalesced with the cephalon, and bearing the reproductive organs; the other attached to the second (first *free*) thoracic somite and bearing the branchiæ[1]—is that some of these thoracic plates are closely covered with fine squamate markings, whilst others are entirely destitute of any kind of ornamentation upon their surface.

I do not think that this is due merely to the condition of preservation of the individual specimen; for if markings were present we should, from the fine-grained nature of the matrix, certainly find them either upon the intaglio or relievo side of the slabs, the specimens being nearly always obtained thus impressed, *in duplicate* as it were, in the matrix.

On the contrary, I am inclined to consider the presence of scale-markings in the one plate and their absence in the other to be due to the circumstance that the scale-marked plate is the outer or first thoracic plate (bearing the ovaries), whilst the smooth plate is the inner or second thoracic plate (the gill-bearing plate), which, like the inner plates to *Limulus* is thinner and more membranaceous than the external operculum.

Judging from the large series of detached portions of this species, preserved in the British Museum, and in the Museum of Practical Geology, Jermyn Street, the largest specimen of *Slimonia acuminata* known could not have exceeded four feet in length; and by far the greater number of individuals were less than three feet long. They cannot therefore be said to equal in size the largest species of the genus *Pterygotus*, which, no doubt, attained a length of at least five feet.

Besides the almost perfect specimen, figured on Plate XVII, which is about 26½ inches in length, there are three small and nearly entire examples of *Slimonia*, measuring respectively: 7¼ inches, 7 inches, and 5¾ inches in length, and 1½ inch, 1¼ inch, and 1 inch in breadth.

The hinder border of the head and each of the six anterior segments is marked in these young individuals with two small subcentral keels or ridges upon their dorsal surfaces.

The integument appears to have been extremely thin; no scale-markings are discernible, and the whole surface is much crumpled up.

Except that at this early stage the young of *Slimonia* seem to be much narrower in proportion to their length, the restored figures on Plate XX might serve to represent one of these small specimens. Portions preserved in section in the British Museum, and in the Museum of Practical Geology, indicate that the anterior segments in *Slimonia* were even more robust than in *Pterygotus* (see Part I, p. 41), whilst the posterior segments were nearly if not quite cylindrical.

Only one species of this singular genus is known, and its remains are, at present, confined to one locality, namely, the Banks of Logan Water, near Lesmahagow, Lanarkshire.

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[1] It is quite possible there may have been a third plate, also branchigerous.

The series of forms, already figured and described, and included in the genera *Pterygotus* and *Slimonia,* although differing among themselves in many important points of structure, have one common distinctive character, namely, the position of the large compound eyes.

In the genera *Stylonurus* and *Eurypterus,* and in the Xiphosura (to be described in Part IV), these organs occupy a more or less *sub-central* position upon the dorsal surface of the carapace, as is the case also in the Trilobita. In *Pterygotus* and *Slimonia,* on the contrary, the eyes are *marginal,* being placed upon the latero-anterior border of the head. The only form which, from the position of the eyes, can be compared with *Slimonia* and *Pterygotus,* is Hall's *Dolichopterus,*[1] an American form, in which the large compound eyes approach very near the latero-anterior angles of the carapace; but, nevertheless, they are *not marginal* eyes, but are really placed upon the dorsal surface of the head, as in *Eurypterus* proper, of which, indeed, Hall makes his *Dolichopterus macrocheirus* a subgeneric form.

For the greater convenience of the palæontological student, the diagnostic characters of each genus of the Merostomata will be given in a condensed form at the conclusion of Part IV.

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[1] 'Geological Survey of New York, Palæontology,' by James Hall, vol. iii, p. 414*, pl. lxxxiii, Albany, U.S., 1859.

PLATE XVI.

UPPER SILURIAN AND DEVONIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

FIG.

1. *Pterygotus raniceps*, H. Woodw. U. Ludlow Rock, Lesmahagow, Lanarkshire. (Drawn from the original specimen in the British Museum.) P. 71.
2. *Pterygotus Banksii*, Salter. The carapace from the Passage Beds at the Ludlow Railway Station. (In Mr. Lightbody's Cabinet.) Pp. 72—74.
3. *Pterygotus Banksii*, head of a very young individual. Downton Sandstone, Kington. (Mr. Banks's Cabinet.)
4. *Pterygotus Banksii*. The posterior segments of the body, with the telson. Passage Beds, Railway Station, Ludlow. (From Mr. Lightbody's Cabinet.)
5. *Pterygotus Banksii*. The anterior half of the body, exhibiting the carapace, six thoracic segments, and the left ectognath or swimming-foot. Upper Ludlow Rock. (Mr. Lightbody's Cabinet.)
6. A metastoma or post-oral plate. Upper Ludlow Rock. (Mr. Lightbody's Cabinet.)
7. *Pterygotus ludensis*, Salter. Posterior portion of body, reduced to two thirds. P. 76.
8. *Pterygotus problematicus?* A penultimate body-segment, showing the short *dorsal* ridge—not *sternal*, as supposed by Mr. Salter.—H. W. (From Mr. Lightbody's Cabinet.) P. 77.

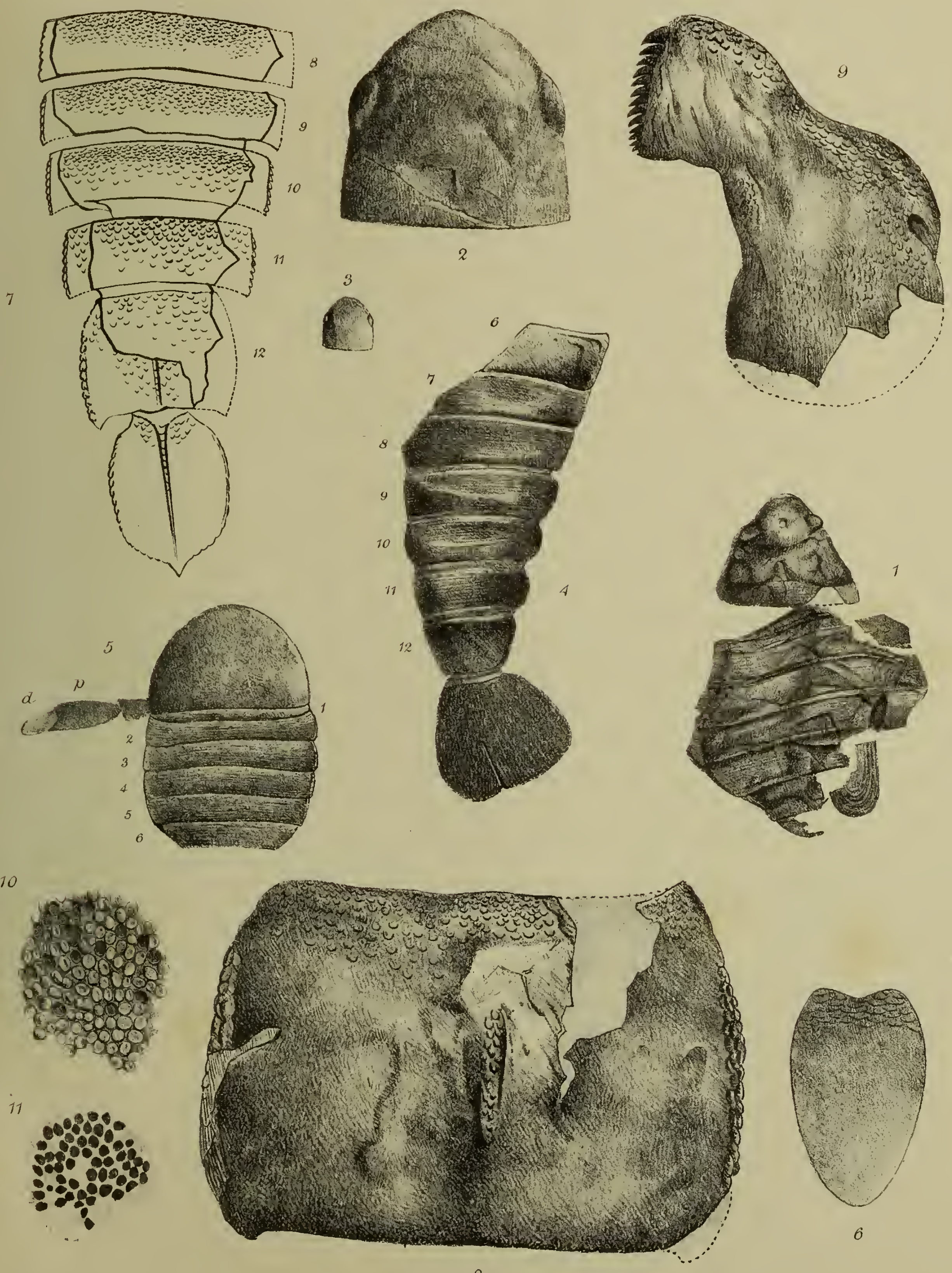
   Mr. Salter remarks: "Perhaps this represents only a variety of *P. ludensis*."
9. *Pterygotus ludensis*, Salter. Basal joint of an ectognath, with short serrations. (Mr. Lightbody's Cabinet.)
10. *Parka decipiens*, Fleming. *Ova* of *Pterygotus*. P. 79.
11. This specimen shows the eggs in section, as black carbonaceous spots, whereas in Fig. 10 the external surface and rounded form of many are well preserved.

    If these eggs were enclosed, like those of the modern *Limulus*, in a hard and horny exchorion, and deposited in the sand in the same manner, we have at once a simple explanation furnished us of their abundance in certain beds.

Figs. 10 & 11 are drawn from specimens obtained by the late Mr. Baugh, and preserved in the British Museum, from the base of the Old Red Sandstone at Trimpley, north of Bewdley.

With the exception of Figs. 1, 10, and 11, these are all re-drawn from Mr. C. R. Bone's excellent figures in plates xii and xiv of Messrs. Huxley and Salter's Monograph on the Eurypteridæ. ('Mem. Geol. Surv.,' Mon. I, 1859.)

U. SILURIAN CRUSTACEA.



A. T. Hollick, del et lith.

W West imp.

Remains of PTERYGOTUS *Raniceps*, *P. Banksii*.
P. Ludensis &c.

PLATE XVII.

UPPER SILURIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

Figs. 1—4.—*Slimonia acuminata*, Salter, sp. P. 105.

FIG.

1. This is by no means the largest, but it is one of the most perfect, specimens met with by Mr. Robert Slimon at Lesmahagow. Both the intaglio and relievo are now preserved in the British Museum.

   The specimen exhibits its ventral aspect.

   The small letters and figures refer to the same parts and organs as indicated in Parts I & II of this Monograph.

2. A detached thoracic plate, exhibiting the tricuspid termination of the median lobe (*c*). From a specimen in the British Museum. P. 114.

3. One of the antennæ, with its serrated basal joint, and also that of the opposing maxilla. P. 109.

4. One of the endognaths. The mandible in this specimen is turned the reverse way. P. 111.

All drawn of the natural size from specimens in the British Museum.

Formation.—Uppermost Ludlow Rock.

Locality.—Lesmahagow, Lanarkshire.

From nat. on stone by J. Erxleben

W. West imp.

SLIMONIA ACUMINATA, *Salter sp.*

PLATE XVIII.

UPPER SILURIAN CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

Figs. 1, 2.—*Slimonia acuminata,* Salter, sp. P. 105.

Fig.

1. The appendages detached from the head, but otherwise found entire, as represented.

   The lip-plate, the great swimming-feet, the endognaths, and even the antennæ, are preserved.

   The specimen is drawn two thirds the natural size.

2. A detached head-shield belonging to a young individual. P. 106.

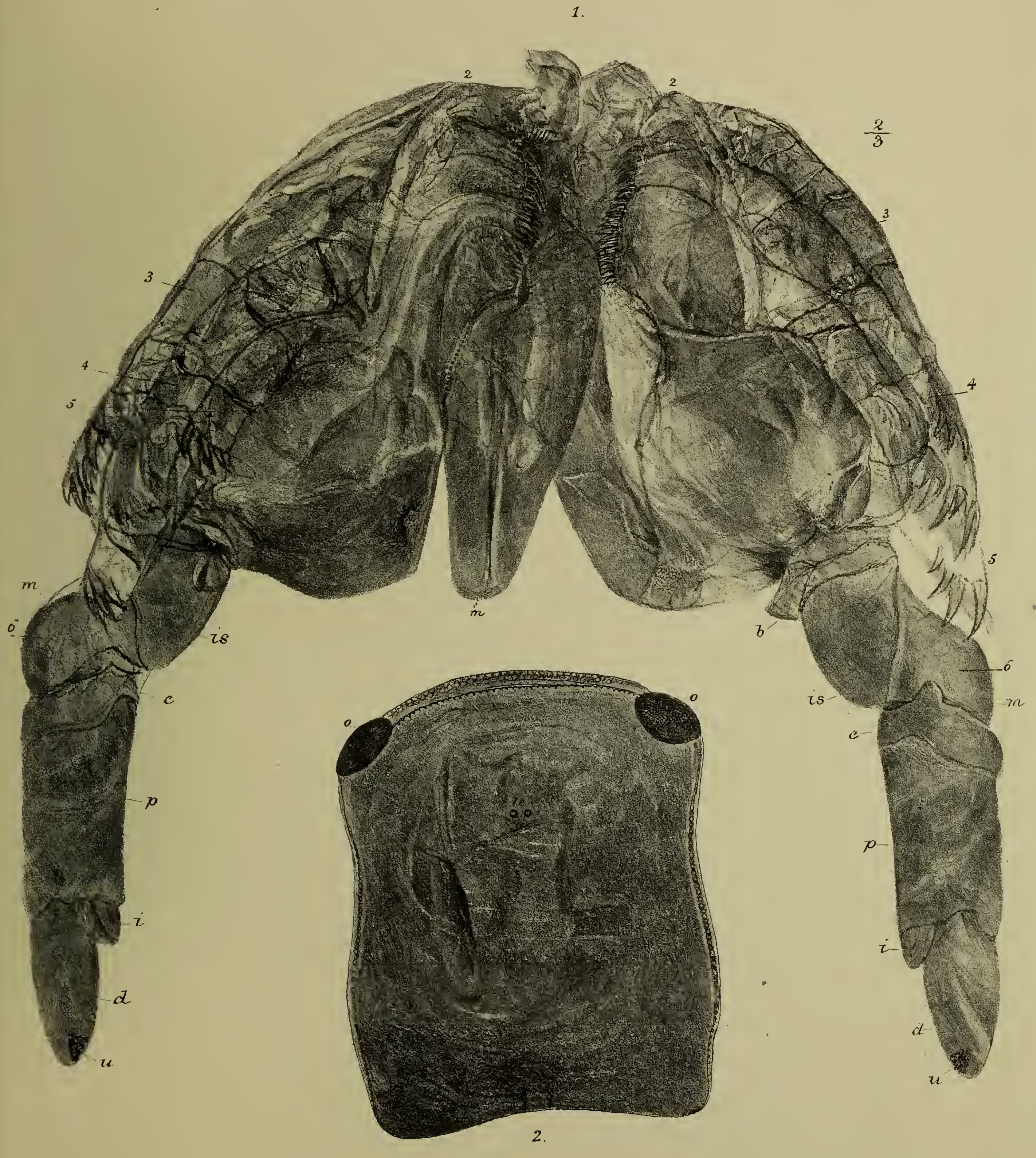
   The large compound eyes (*o, o*) and the larval eye-spots (*l e*) are well seen.

   Drawn of the natural size. From specimens in the British Museum.

   Formation.—Uppermost Ludlow Rock.

   Locality.—Lesmahagow, Lanarkshire.

U. SILURIAN CRUSTACEA.



From nat. on stone by J. Erxleben.

W. West imp.

SLIMONIA ACUMINATA *Salter. sp.*

PLATE XIX.

UPPER SILURIAN CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

Figs. 1—4.—*Slimonia acuminata*, Salter, sp. P. 106.

Fig.

1. The largest perfect head-shield known.

   (*o*, *o*), the compound eyes.

   (*l*, *e*), larval eye-spots.

   Drawn the natural size.

2. One of the compound eyes of a small individual, enlarged four times in order to show the facets.

3. A detached leaflet from the branchiæ of the natural size. P. 115.

4. A series of branchiæ preserved united. Drawn of the natural size. P. 115.

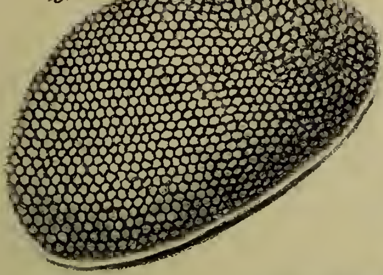
From specimens in the British Museum.

Formation.—Uppermost Ludlow Rock.

Locality.—Lesmahagow, Lanarkshire.

U SILURIAN CRUSTACEA.

2.



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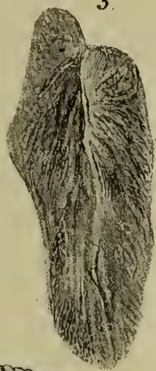

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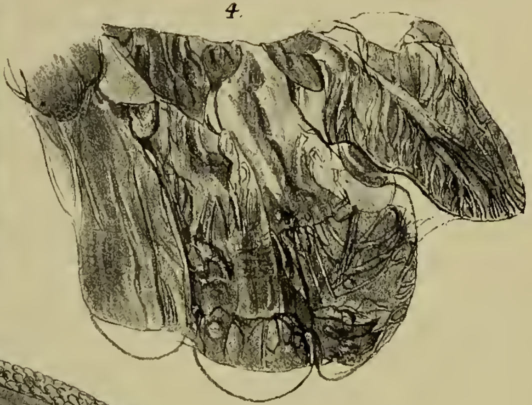

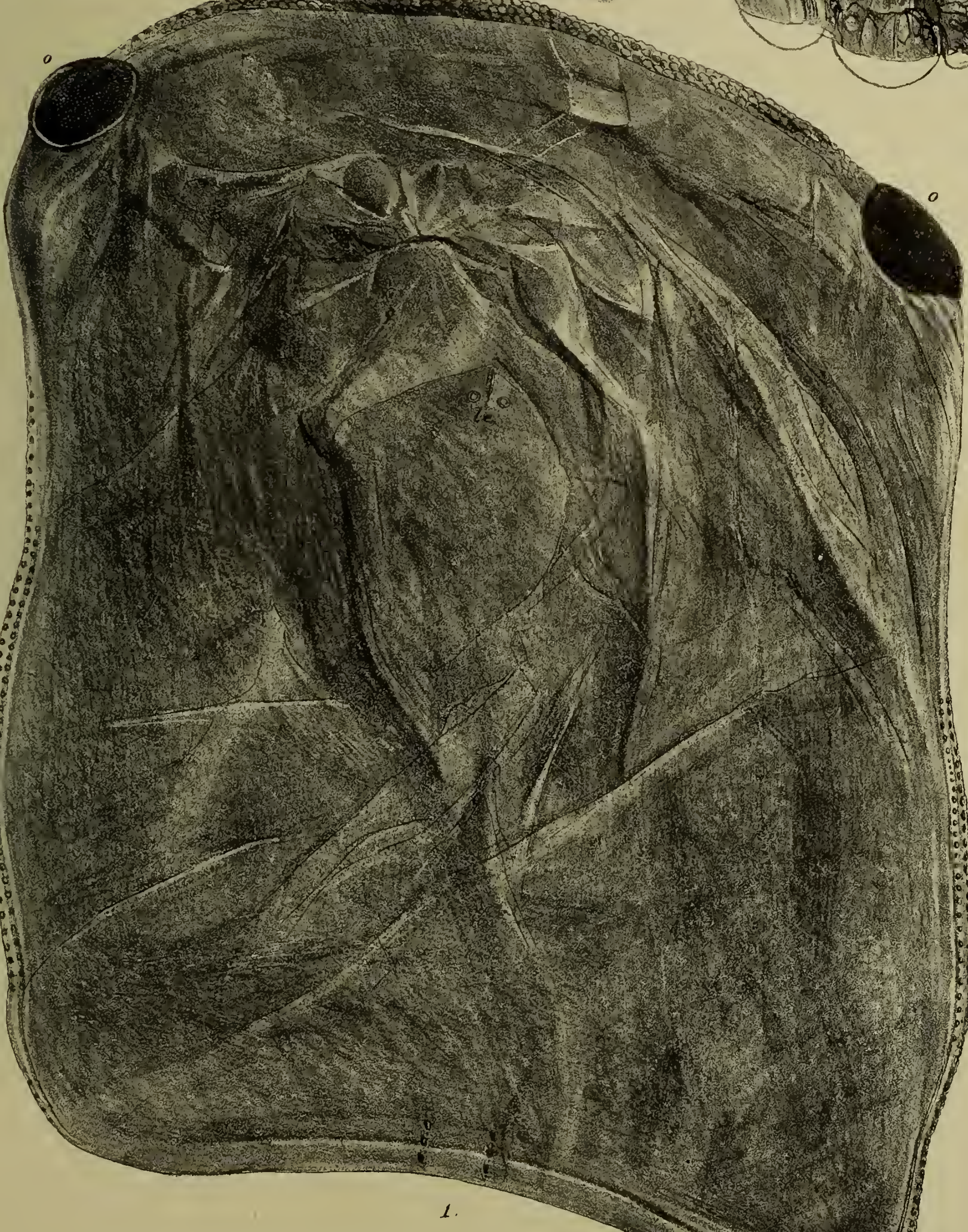

1.

From nat. on stone by J. Erxleben.

W. West imp.

SLIMONIA ACUMINATA *Salter* *sp.*

PLATE XX.

UPPER SILURIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

Figs. 1—4.—*Slimonia acuminata*, Salter, sp. P. 105.

FIG.		
1.	Upper side. Restored.	
2.	Under side. ,,	
3.	Median appendage of thoracic plate or operculum	(male ?).
4.	Ditto	(female ?).

Segments I—VI. Cephalic.[1]

,, VII—XIII. Thoracic.[2]

,, XIV—XX. Abdominal.[3]

---

[1] One cephalic segment (that bearing the antennules) is suppressed in the Eurypteridæ.

[2] The first thoracic segment bearing the thoracic plate or operculum is coalesced with the head-shield both in *Limulus* and in *Pterygotus*, &c.

[3] In the explanation to Plate VIII, the 14th Segment is included as thoracic; this is an error, and should be corrected.

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U. SILURIAN CRUSTACEA.

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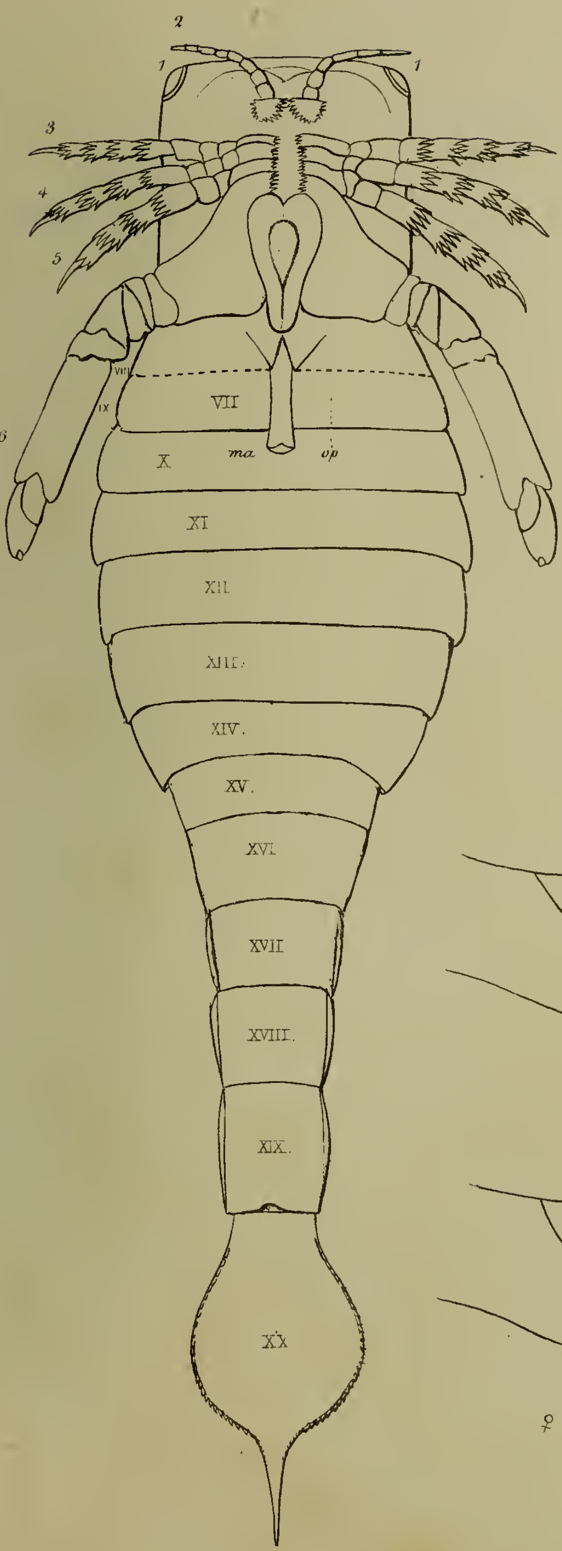

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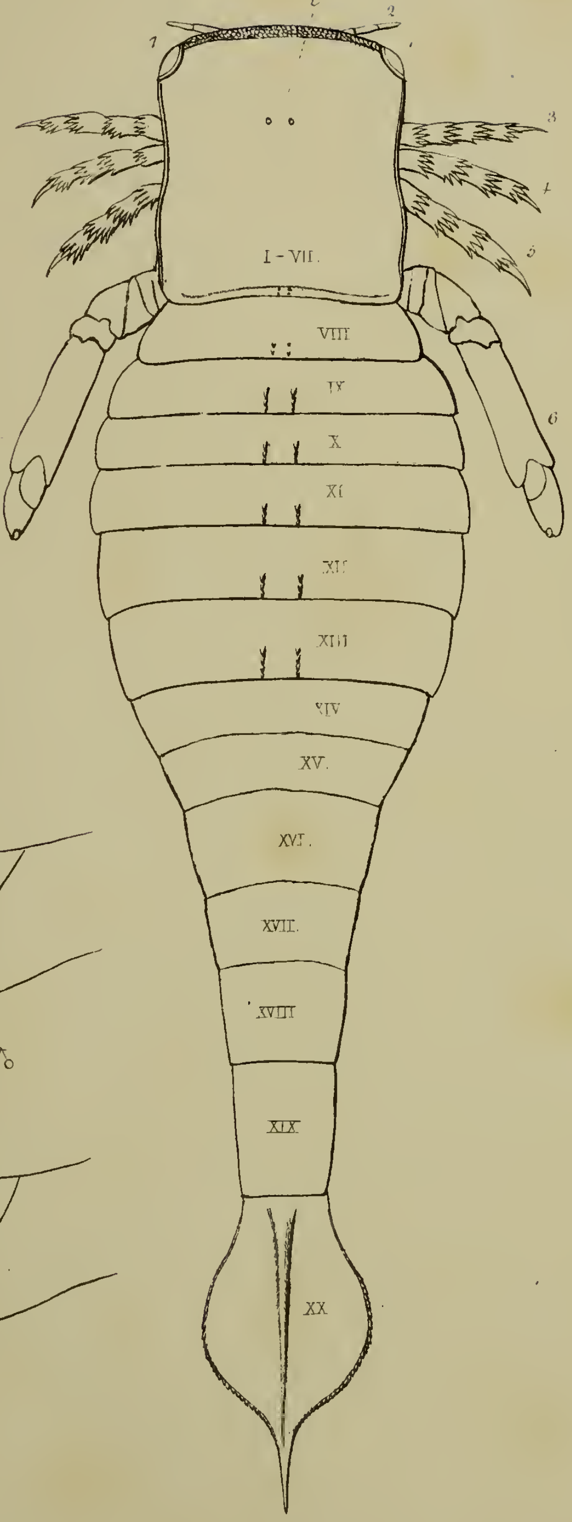

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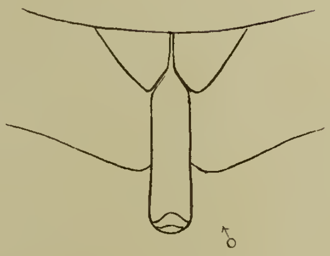

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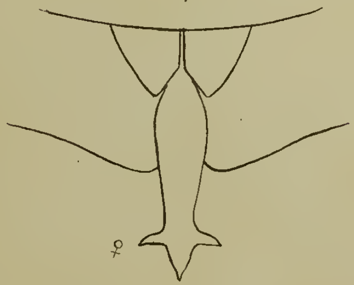

A. T. Hollick, del et lith.

W. West imp.

SLIMONIA ACUMINATA, *Salter, sp.*

(Restored.)